WAAGENOPHYLLIDAE

by

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Born in Sendai, 6, December, 1891 ; graduated from Tohoku Univ. in Sendai June 1915 ; Lecturer in the same Univ. October, 1916 ; Degree of Rg. H. (Ph. D. in Science), May 1920 ; Professor (Geology and Palaeontology) in Taihoku Univ. in Taihoku, Taiwan, 1928–1945 ; Professor in National Taiwan Univ., Taipei (former Taihoku), Taiwan (Formosa), 1945–1949 ; Professor in Kanazawa Univ., Kanazawa, 1950–1952 ; Professor in Hokkaido Univ., Sapporo, 1952–1955 ; retired March, 1955 (age limit).

The present paper is dedicated to our respected teacher, Prof. I. HAYASAKA, who has greatly promoted the research of Palaeozoic corals in Japan and established the genus *Waagenophyllum* in 1925.

to PROFESSOR I. HAYASAKA

WAAGENOPHYLLIDAE

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Contents

ABSTRACT

Important skeletal elements which will adequately characterize and classify the Waagenophyllidae are described in detail. Nearly all of the species belonging to this group hitherto known to us except for the genus *Polythecalis* are reviewed and new forms are described.

Further, a new means for their classification is presented and phylogeny of this group of corals is compiled.

In addition, Permian stratigraphy based on those corals and palaeozoogeography in the Permian seas are discussed in a concised form.

FOREWORD

Waagenophyllid corals were first recognized by WAAGEN and WENTZEL in 1886 among many other Salt range fossils. At that time they already were aware of the peculiar nature of those corals, yet they considered these corals to be assignable into *Lonsdaleia*. And the idea has been adhered by many workers in that the waagenophyllids constitute a branch of the family Lonsdaleidae.

It was in 1915 when YABE and HAYASAKA, however proposed waagenophyllids to be separable from *Lonsdaleia* based on its having no " vesiculate zone " (lonsdaleoid dissepiments in the present sense). Nevertheless, they also placed these corals into the subgenus under *Lonsdaleia*, and named it *Waagenella*, while paying little attention to the peculiar structure of clinotabulae and elongate dissepiments of this coral. They diagnosed the subgenus *Waagenella* to have " conically elevated tabulae ". The subgenus in this sense, according to them, seems to be rather close to the genus *Corwenia* established by SMITH and RYDER in 1926. The subgeneric name, *Waagenella* was subsequently changed into *Waagenophyllum* by HAYASAKA in 1925 by a later discovery of the homonym of the former.

YABE and HAYASAKA stated that *Waagenella* (later *Waagenophyllum*) contained three major groups, which were the *Lonsdaleia* (*Waagenella*) *indica* group, *Lonsdaleia* (*Waagenella*) *salinaria* group and *Lonsdaleia* (*Waagenella*) *rugosa* group respectively.

Of these, the first group is known as *Waagenophyllum* which is in current use. The second one was distinguished by GRABAU in HUANG (1932) to represent a new cerioid genus, *Wentzelella*. While the last one is actually *Corwenia*, later established by SMITH and RYDER. In short, " *Waagenella* " was thus originally a large, heterogenous " subgenus ".

Later investigations, however revealed such peculiar structures as clinotabulae and elongate dissepiments, already noticed by WAAGEN and WENTZEL and later defined by HUDSON 1958 and by us in the present paper to be more important in characterizing the waagenophyllid corals, and the subgenus *Waagenophyllum* was raised to generic rank by GRABAU in 1931, as above stated. He also generically distinguished the second group of *Waagenella* of YABE and HAYASAKA and proposed to call it the genus *Wentzellela*. Thus two genera became established among waagenophyllid corals.

However, the entire waagenophyllid corals continued to be regarded as a group of the family Lonsdaleidae, until in 1950 WANG first advocated that waageno-

phyllids should be an independent subfamily.

In 1958 HUDSON newly regarded waagenophyllids to consistute a family, by placing special stress on the presence of clinotabulae in this group of corals, although WANG in 1950 did dot view the mode of inclination of tabulae to be an important character in taxonomy. HUDSON included such genera as *Wentzelella*, *Waagenophyllum*, *Wentzelloides*, *Polythecalis*, *Ipciphyllum* and *Wentzelophyllum* into his newly established Family Waagenophyllidae. Of these the last mentioned two genera were newly proposed by him on that occasion.

In Japan the research history on this group of corals can be traced back to 1902, when YABE described a coral, which is now known as *Waagenophyllum akasakense*, from the Akasaka limestone. Since then numerous studies have been made: YABE and HAYASAKA (1915), HAYASAKA (1924), OZAWA (1925), YABE and MINATO (1944 a, b, 1945, a, b) MINATO (1944, 1949, 1955, 1962), IGO (1959), YOKOYAMA (1960), KAWANAO (1959), SAKAGUCHI and YAMAGIWA (1958, 1963), YAMAGIWA (1960, 1962), MAEDA & HAMADA (1962) and KAMEI et al (1962).

In our department, new materials on waagenophyllid corals have been recently added in increasing numbers by our team including the authors in their recent field work on the Younger Palaeozoics in Japan developing at various localities.

The results of study of these new materials will be presented in this paper, in which the results of a review on the older material kept at our disposal will also be included in a concised form. Further we wish to take this opportunity to review nearly all the forms belonging to Waagenophyllidae, hitherto described.

According to our recent study, there are more than 170 species belonging to Waagenophyllidae, of these 26 species are newly named in this paper. In the course of the present study we also became aware of the fact that certain species groups need their own new genera and sugbenera because of reasons, which will be stated in detail later. The newly proposed genera and subgenera in the present paper are: *Pavastehphyllum* (*Pavastehphyllum*), *Pavastehphyllum* (*Sakamotosawanella*), *Pavastehphyllum* (*Thomasiphyllum*), *Praewentzelella*, *Akagophyllum*, *Pseudohuangia*, *Chihsiaphyllum*, *Waagenophyllum* (*Chaoiphyllum*), *Yokoyamaella* (*Yokoyamaella*), *Parawentzelella* (*Miyagiella*), and *Yokoyamaella* (*Maoriphyllum*). *Lonsdaleiastraea* may also be placed into Waagenophyllidae in our opinion, in addition to other genera which already have been assigned into this family by various workers.

Thus, Waagenophyllidae may be considered as a great family containing numerous genera. Of these, solitary forms are as follows: *Iranophyllum* (*Iranophyllum*) with 4 species, *Iranophyllum* (*Laophyllum*) with 2 species, *Pavastehphyllum* (*Pavashtehphyllum*) with 2 species, *Pavastehphyllum* (*Sakamotosawanella*) with 3 species, *Pavastehphyllum* (*Pseudocarniaphyllum*) with 2 species and *Pavastehphyllum* (*Thomasiphyllum*) with 4 species. In fasciculate forms: *Praewentzelella* with 3

species, *Huangia* with a single species, *Akagophyllum* with 7 species, *Waagenophyllum* (*Liangshanophyllum*) with 3 species, *Waagenophyllum* (*Waagenophyllum*) with 14 species, *Waagenophyllum* (*Huayunophyllum*) with 3 species, *Heritschiella* with 1 species, *Pseudohuangia* with 10 species and *Chihsiaphyllum* with 2 species.

Further, as massive forms the following can be enumerated: *Yokoyamaella* (*Yokoyamaella*) with 6 species, *Yokoyamaella* (*Maoriphyllum*) with 5 species, *Ipciphyllum* with 14 species, *Parawentzlella* (*Parawentzlella*)with 7 species, *Parawentzelella* (*Miyagiella*) with 2 species, *Paraipciphyllum* with 2 species, *Wentzelella* (*Wentzellella*) with 7 species, *Wentzelella* (*Szechuanophyllum*) with 4 species, *Wentzelellites* with 3 species, *Lonadaleiastraea* with 4 species, *Wentzelloides* with 1 species, *Wentzelophyllum* with 23 species, including doubtful forms.

Incidentally, the geographical distribution of waagenophyllid corals is interesting. As well known, nearly all the forms reviewed by us, are distributed only in the Tethys sea area of Europe and Asia, with the exception of two or three species. Actually, the entire extent of the Permian Tethys sea seems to be well indicated by their distribution of species in most genera belonging to Waagenophyllidae.

In addition, many good horizon indicators are found among them, especially in the Permian stratigraphy, so that they can be used in interregional as well as in international correlations with certainty. Thus, the waagenophyllid faunal zones are newly established in the Permian stratigraphy, which are defined by the predominance of species groups belonging to certain genera or subgenera or restriction of their stratigraphic range. As tabulated in the accompanying diagram, recognized zones are designated. They are as follows:

Huangia zone = Middle Carboniferous, *Fusulinella—Fusulina* zone
Pavastehphyllum (s. l.) zone = *Pseudoschwagerina* zone
Akagophyllum, *Polythecalis*, and *Wentzelophyllum* zone = *Pseudofusulina* zone
Pseudohuangia and *Lonsdaleiastraea* zone = *Parafusulinana* zone
Ipciphyllum zone = *Neoschwagerina* zone
Waagenophyllum zone = *Yabeina* zone

ACKNOWLEDGEMENTS

Many persons have kindly rendered assistance in various ways during the course of the present study.

First of all, our sincere gratitude is here expressed to our respected teacher Professor Doctor ICHIRO HAYASAKA for his continuous guidance and encouragement. It is a great pleasure to us to be able to dedicate this paper to him, who is one of the pioneers in the study of waagenophyllid corals.

We wish also to express our hearty thanks to the staff of our department, who have patiently helped us in field, when we made geological investigations at the typical areas of the Japanese Palaeozoics. Especially we are much indebted to doctors H. TAKEDA, K. NAKAMURA, S. HONJO, Y. HASEGAWA, M. MATSUI, S. UOZUMI and T. FUJIE.

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Professor E. MALZAHN (Hannover) kindly placed some waagenophyllid corals from the Carnic Alps at the authors disposal. Dr. J. STÖCKLIN, Geol. Surv. Iran kindly displayed some waagneophyllid corals of Iran from his collection, when the senior author visited him in Teheran in Ocotober 1963. Also Professor A. VON SCHOUPPÉ (Münster/Westf.) and Professor H. GERTH (Bonn) kindly offered information to the senior author on Timorian waagenophyllids. Professor D. HILL (Brisbane) also kindly informed us on the geological horizon of waagenophyllid corals of New Zealand through her valuable correspondence.

Professor K. ICHIKAWA (Osaka), Professor S. IMAMURA (Hiroshima), Dr. M. KAWANO (Yamaguchi) and Professor S. MATSUSHITA (Kyoto) kindly placed at our disposal certain slides of Japanese corals kept at their institutions for study, when the senior author recently visited them. To all these respected scientists the senior author is greatly obliged and indebted.

Further, during his stay in England from 1959 to 1961, the junior author was able to examine many waagenophyllids stored at the British Museum of Natural History in London, the Sedgwick Muesum of Cambridge and the Royal

Scottish Museum of Edinburgh, through the courtesy of doctors H. DIGHTON THOMAS, C. L. FORBES and C. D. WATERSTON. Also he was very happy indeed to be given the opportunity to aquire new knowledges on these corals either through the suggestions given by Dr. H. D. THOMAS in regard to many references or through information exchange. The junior author is greately indebted to these scientists for their kindness.

Finally, last but not least, we wish to say that we appreciated the cooperation given us by Mr. S. KUMANO in taking many photos and making drawings for the present paper. Mrs. C. MINATO typed the entire manuscript.

Sincere thanks are due to Mr. KUMANO and Mrs. MINATO here.

PART 1. MORPHOLOGY, EVOLUTIONAL TRENDS, STRATIGRAPHICAL ZONATION, PALAEOECOLOGY, GEOGRAPHICAL DISTRIBUTION AND PHYLOGENY OF WAAGENOPHYLLIDAE

1) ON THE MORPHOLOGY OF TABULAE, DISSEPIMENTS AND WALLS OF WAAGENOPHYLLIDAE.

Waagenophyllidae containing a large number of species, is seemingly polyphyletic in origin, but all the species seem to have rather smaller corallites in common. In which the axial column is usually simply constructed and dissepiments are generally in concentric arrangement in cross section. Further, they have a peculiar structure both in tabularium and dissepimentarium.

Namely, in waagenophyllid corals, clinotabulae develop without exception, besides variously inclined transverse tabulae. Moreover, elongate dissepiments, newly defined in this paper, are found in almost all species of waagenophyllids hitherto known, in addition to normal globose dissepiments. With special regard to these structures a brief description will be first given in the following.

TABULAE

As above stated, tabulae of Waagenophyllidae are in general composed of two kinds of plates: clinotabulae and transverse tabulae respectively.

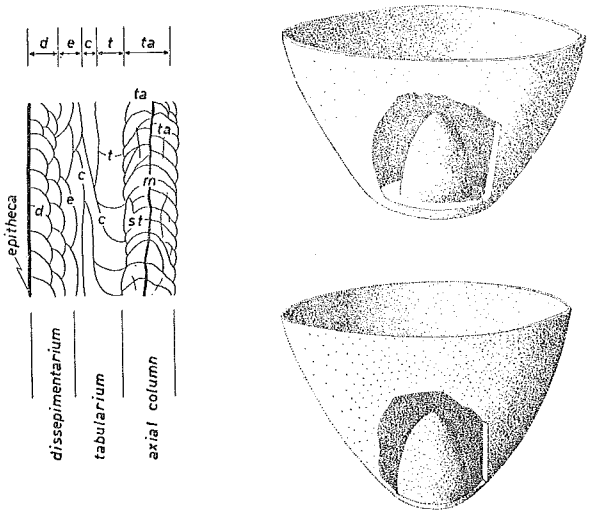
Of these the former usually begins to develop from the boundary area between dissepimentarium and tabularium towards tabularium. While the latter are situated at the preiaxial region, surrounding the axial column.

The clinotabulae are structures which may be described as a cone within a cone. They are however in reverse disposition, with the pointed top truncated by sub-horizontal transverse tabulae (Fig. 1.). Hence the clinotabulae, now in question appear to incline from the periphery of the corallites towards the inside of corallite.

Although they show variable inclination from species to species, they mostly incline very steeply. While the transverse tabulae are also variously inclined, they usually gently incline at a lesser degree.

Before going into any further descriptions, especially in regard to the inclination of structures in corallites, we think, however that it may be necessary at first to define the orientation of thin sections, because even the same structure appears to show different inclinations in different orientated sections. (Fig. 2)

Further, corallites are not always longitudinally straight but in fact slightly curved or weakly undulated, so that tabulae or any other structures are apt to



Text-figure 1

Tabulae and dissepiments in waagenophyllid corals

ta : tabellae of axial column
m : median plate
st : septal lamellae of axial column
t : transverse tabulae
c : clinotabulae
e : elongate dissepiments
d : globose dissepiments, including lonsdaleoid dissepiments

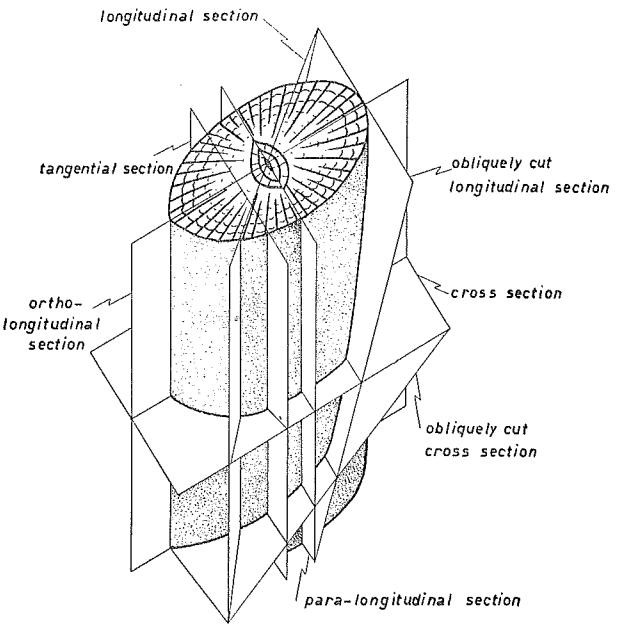
Right hand figures show idealized form of large clinotabulae and narrow transverse tabulae.

appear to have different inclination from place to place in longitudinal section, instead of their possessing originally the same inclination.

The definition on orientation of sections of corallites will be thus given in the following. First of all, there are sections cutting through the axis of corallites, which are termed the longitudinal sections. Secondly, sections were cut at right angles to the axis of corallites and called the cross sections.

There are also tangential sections here designated, which do not cut through the axis of corallites, but along the axis of corallites: that is to say, they are cut parallel to the axis of corallites, but not centrally. The fourth sections are oblique sections, which are cut neither along or through, nor perpendicular to the axis of corallites. Two types can be distinguished among oblique sections: obliquely cut longitudinal sections and obliquely cut cross sections.

Further, two more sections would be better termed for the sake of correct description of structures of corallits. One of them is the longitudinal section cut



Text-figure 2
Orientation of sections of waagenophyllid corals

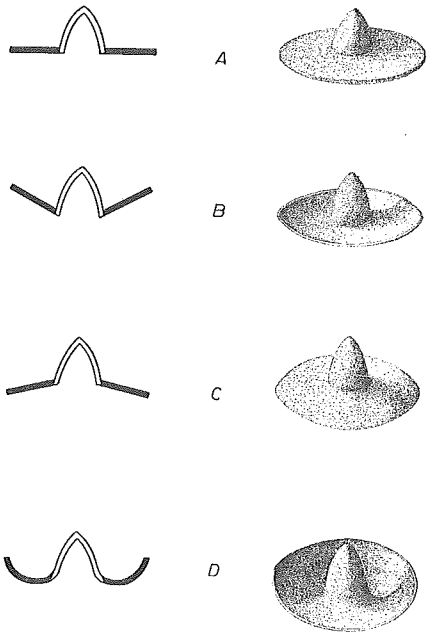
through the plane of counter and cardinal septa, and they may be called paralongitudinal section, while the other one is a longitudinal section cut at right angles to the para-longitudinal section which may be called ortho-longitudinal section.

As it is quite obvions, diameters of axial column, for example, are different in length along the counter and cardinal septum and the direction is at right angles to those two septa. Hence it is necessary to distinguish such two sections as para- and ortho-longitudinal sections in the description.

Now, the maximum inclination of clinotabulae can be exactly measured at longitudinal sections and it is generally more than 60 degrees in most species of waagenophyllid corals. The clinotabulae usually face their convex sides outwards and at the same time downwards, but rarely inwards and upwards. In any event, however they gradually change their inclination towards their lower ends, where they become nearly horizontal or are only a little inclined and unite with transverse tabulae.

The term transverse tabulae was first proposed by HUDSON in 1958. The structures occupy a relatively narrow space in general, immediately outside of the axial column. The transverse tabulae are essentially horizontal or nearly so, yet they sometimes show quite various inclination. Eevn in the same corallites, some of them incline inwards and downwards, while others show a reverse in-

clination, besides the flat ones. Also their steepness in inclination is changeable at certain places of the corallites. In short, the following three major groups can be distinguished among transverse tabulae: horizontal or nearly horizontal transverse tabulae (= so-called flat or horizontal tabulae), tabulae inclined inwards and downwards (= so-called inclined tabulae) and tabulae which directly begins to incline from the outer surface of axial column and incline outwards (= periaxial tabulae) (Fig. 3). Further, there is a type showing a combination of periaxial and inclined transverse tabulae.



Text-figure 3
Transverse tabulae in waagenophyllid corals
A: " horizontal tabulae "
B: " inclined tabulae "
C: " periaxial tabulae "
D: combination of periaxial and inclined transverse tabulae.

Among them, the first group is quite distinct from clinotabulae in inclination; while the second group is sometimes somewhat indistinguishable from clinotabulae owing to the same direction of inclination but the latter is more larger (more longer in longitudinal section), more outwardly spaced and generally more steeply inclined than the former. The distinction is obvious between the periaxial (transverse) tabulae and clinotabulae in their occupied area and direction of inclination.

Further, the transverse tabulae as a whole are more gently inclined than clinotabulae, although the former shows quite a large variability in inclination.

Moreover, the transverse tabulae in general seem to be different in density in comparison to clinotabulae. Thus the clinotabulae may be quite distinct from transverse tabulae.

In short, the width of tabulae, especially that of the transverse tabulae must be dealt with briefly, because they appear to be different in width through different oriented section. If they were marginally cut, they appear to be shorter than their true breadth. In any event, however, the transverse tabulae are in general rather narrow in most species in this group of corals, and this can be accordingly regarded as one of the essential characters in Waagenophyllidae.

DISSEPIMENTS

In Waagenophyllidae, we find at least three kinds of dissepiments. One of them is non septal in disposal which is the so-called lonsdaleoid dissepiment, while the other two are intereseptal in arrangement.

One of these two intereseptal dissepiments is a type representing normal globose dissepimental vesicles in longitudinal section; such dissepiments may be here designated as normal dissepiments or globose dissepiments from their form; while the other dissepiments are here designated as elongate dissepiments.

The globlose dissepiments occupy in general a more outer space in dissepimentarium than elongete dissepiments.

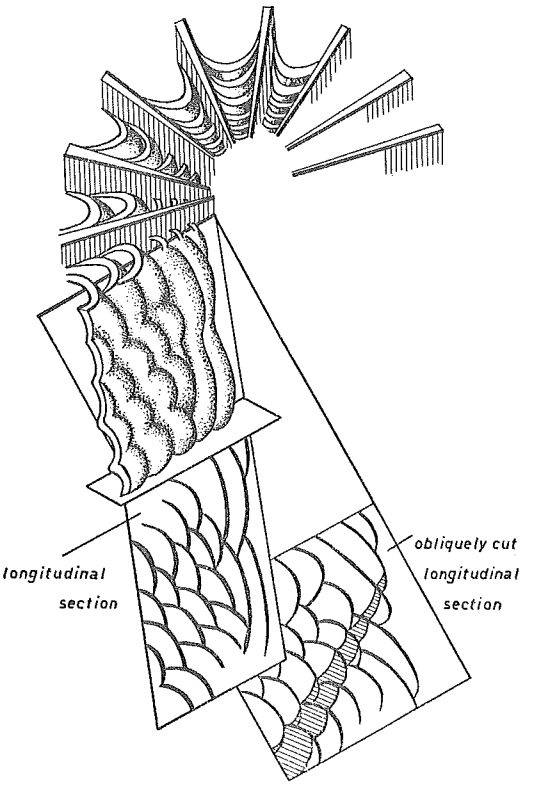
In cross section, the elongate dissepiments are however hardly distinguishable from globose dissepiments in general, yet the former is disposed in a more inner area than the latter as above stated; further the former is generally represented by cut edges which present approximately straight or slightly curved lines, owing to their slight convexity, against curved lines of globose dissepiments. In addition, the elongate dissepiments are generally more densely arranged than the globose dissepiments.

In the longitudinal section, distinction between elongate dissepiments and globose dissepiments is quite obvious. Needless to say, the former occupies the space at a more inner part of dissepimentarium, while the latter occupies a more outer space. Further, the elongate dissepiments are in general elongated in form, longitudinally in disposal, with convex surface facing inwards. On the contrary, the globose dissepiments are subround, arranged in an oblique row, facing their maximum convexity upwards and at the same time inwards. Meanwhile, there is a case in which elongate dissepiments show an apparent resemblance to clinotabulae in some oblique sections. The elongate dissepiments are definitely vesicles, though quite elongated in form, and they are vertically arranged or placed in only slightly inclined rows, yet they may appear to incline in a similar manner to clinotabulae in oblique sections, owing to their slight convexity and to their originally

slight inclination, even though they were less strong.

Moreover, elongate dissepiments become sometimes so thin especially at their upper and lower ends that such two parts sometimes might be misunderstood to be not closed in thin section. Hence elongate dissepiments may appear to be similar to clinotabulae and it may be difficult to distinguish elongate dissepiments from the latter.

In reality, when HUDSON proposed the new term of clinotabulae in 1958, he defined this structural term to be of a wide sense than our present usage. Namely, his clinotabulae included not only such structure as our clinotabulae but also elongate dissepiments here newly designated. His original description regarding clinotabulae runs as follows: " Tabulae, vertical or steeply inclined downwards to axis, usually intersepta. May be simple, flat, or shallowly curved (convex surface towards axis) and continuous with transverse tabulae or compound or elongate-cystose. May simulate dissepiments."



Text-figure 4

Globose dissepiments and elongate dissepiments in waagenophyllid corals.

The structure previously described by HUDSON to be compound or elongate-cystose is thus our elongate dissepiments, which would be better distinguished from clinotabulae (in our sense) for the reason stated below. (Fig. 4)

First of all, as it was stated elongate dissepiments are interseptal in disposition without exception as in the case of normal, globose dissepiments in general. Secondly, elongate dissepiments are always closed at their upper and lower ends like common dissepimental vesicles, while clinotabulae gradually tend to open towards the axis of corallites and unite with transverse tabulae with their lower ends but are not closed as vesicles. Thirdly, elongate dissepiments are situated in corallites at a more outer space than clinotabulae.

Thus elongate dissepiments should be definitely distinguished from clinotabulae. Further, it may be needless to say that the former cannot be confused with normal dissepiments through the reasons stated in the foregoing pages.

However, in some species, clinotabulae here defined are so poorly developed, that there is a case in which one may be apt to believe only elongate dissepiments to be developed at the outer area of transverse tabulae.

The interseptal normal dissepiments being distinct from elongate dissepiments, are in general arranged in a concentric pattern in the cross section. In the longitudinal section, globose vesicles, appear to be arranged in oblique rows, facing their convex sides inwards and upwards. In obliquely cut longitudinal sections, however they appear to be arranged somewhat vertically. On the contrary, the originally vertically arranged elongate dissepiments appear somewhat to be oblique in a row. To know the exact orientation of the thin section is therefore of prime importance in distinguishing the elongate dissepiments from the globose ones.

Concerning lonsdaleoid dissepiments, no special remarks seem to be necessary in this group of corals.

WALLS

In solitary as well as fasciculate forms of Waagenophyllidae, two groups with respect to the walls are recognizable. One of them is a rather thin wall, while the other is strengthend by a relatively thick layer of " stereoplasmic " deposits. For instance, the walls of *Waagenophyllum indicum* (WAAGEN et WENTZLE) belongs to the first category, while that of *Waagenophyllum virgalense* (WAAGEN et WENTZEL) belongs to the second group.

Concerning the walls of massive forms, similarly two cases may be expected. However, we are of the opinion that the walls of massive forms should be defined more in detail in order to classify these corals.

As a simple case, it is pointed out that the walls are observable in nearly all species belonging to the genus *Ipciphyllum*. They are apparently thin, nearly straight or are slightly undulating or irregularly zig-zagging in the cross section,

with or without septal denticles. In most cases of *Ipciphyllum* such denticles are very thin and only sporadically found, if any.

Such a wall may be safely termed a thin wall to distinguish it from all other types of walls found in massive Waagenophyllidae. In a more detailed observation, however, even such thin walls are generally composed of two parts: the inner and outer part. Namely, the outer part is generally composed of a less dark or rather colourless layer presenting a fibrous structure. The elongation of fibers tends to be perpendicular to the general trend of walls. Generally speaking, such a fibrous layer is very thin, besides showing colourless, so that such a type of wall is thin, especially under low magnification.

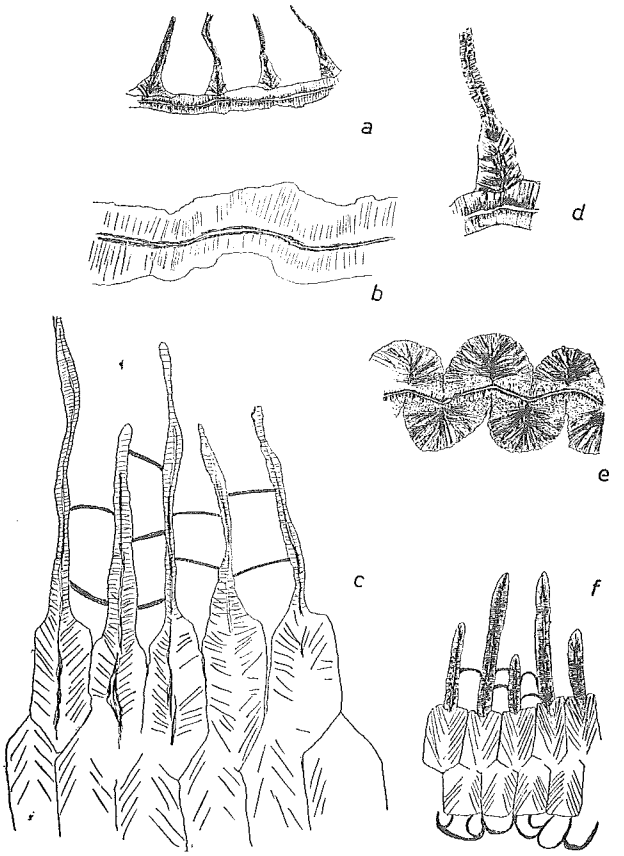
On the other hand, the inner part is composed of a black layer in which a thin translucent layer is occasionally observable. In fact, such a translucent layer is variously developed even in the same corallite, or different corallites belonging to the same corallum.

However, there is a case in which such a translucent layer is highly developed in certain species, while rather indistinct in another species. In spite of this, we wish to treat the wall as being thin, while putting the degree of development of the translucent layer aside for a while.

Next, the wall designated here as a thick wall, closely resembles the thin wall in general appearance and it is not essentially different from the latter. The thick wall here defined is, however, thicker and slightly more coloured in the outer layer than in the thin wall above described. Especially the thick wall may be sometimes clearly distinguishable from the latter by observation under low magnification. Such a type of thick walls are found in many species belonging to *Parawentzelella* (*Parawentzellela*) for example.

The walls found in many genera such as *Wentzelella*, *Yokoyamaella*, *Wentzelloides*, *Wentzelophyllum*, *Polythecalis* for instance are originally very thin and may belong to the thin wall above defined. Namely, they are very thin and straight, sub-straight, curved, zig-zagging or hightly undulating in the cross section.

However, in such genera, the basal part of septa or septal denticles are generally very thick, and completely jointed to each other at the periphery of corallites along the thin walls. Further, such thickened parts of septa and septal denticles are uniform in length at each corallite or corallum, besides they often stop growing directly towards the axis of coralites as mere major, minor or more higher order of septa.. In fact, such thickened septal structure forms a " stereozone " at the periphery and is observed to form an outer layer of the thin wall. Namely, such thickened septa and denticles seem to be entirely compensative for the thin wall from a view point of their function. We would like accordingly to call such septa and denticles under the name of mural septa, and the walls strengthend by mural septa as the septal wall.



Text-figure 5

Various types of walls of massive Waagenophyllidae

(Magnification in the same scale except for d)

a) Thin wall, *Ipciphyllum laosense* (PATTE)
b) Thick wall, *Parawentzelella* (*Parawentzelella*) *regularis* FONTAINE
c) Relatively wide septal wall. Major, minor and tertiary septa are directly growing from the mural septa in this case. *Wentzelloides maiyaensis* YABE et MINATO
d) Septum and thin wall, highly magnificated, *Ipciphyllum laosense* (PATTE)
e) A kind of septal wall which may be called beading type, *Wentzelophyllum felseri*, sp. nov.
f) Septal wall of *Yokoyamaella* (*Yokoyamaella*) *yokoyamai* (OZAWA)

Incidentally, the septa of Waagenophyllidae are in general of the diffuso-trabecular type in fine structure but their basal part near the wall commonly shows a trabecular type in which the fibrous structures diverge outwards in the cross section.

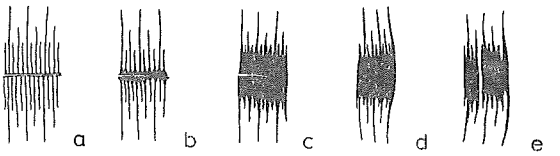
Generally speaking, the basal part of septa with trabecular structure is slighlty thicker than other parts of the septa with diffuso-trabecular type (M. KATO, 1963). For instance, even in *Ipciphyllum* in which the wall is thin, septa are slightly thickkened at the periphery. And the thickened part of septa generally shows a trabecular structure instead of a diffuso-trabecular one.

However, in *Ipciphyllum*, the basal part of septa is not so thickened as to be jointed with each other and to form a definite stereozone. In fact, in this genus septa are still widely apart from each other even at the periphery.

On the contrary, in the septal wall, mural septa with trabecular structure are especially dilated to form a definite stereozone. There is in any event a marked contrast in thickness between the mural septa with trabecular structure and the septa with diffuso-trabecular one, whenever the latter may be continuosly merged from the former without any remarkable boundary in between.

Now, among septal walls a few different types can be distinguished based on the appearance of the stereozone at the periphery of corallite. For example, the beading wall here designated is the wall in which the original thin wall is minutely undulated in the cross section and is strengthened by low and somewhat semicircular mural septa, in giving an appearance of beading as a whole.

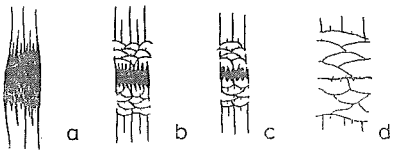
Actually, such a type of wall is widely found in many species beonging to *Wentzelophyllum* (*Wentzelophyllum*). In such coral, the mural septa generally do not directly grow to the septa with diffuso-trabecular structure, and there is nearly always a wide or narrow vesiculate zone of dissepiments in between. Therefore,



Text-figure 6

Diagrams showing gradual change in mode and appearance in wall in *Wentzelella* and *Wentzelellites*.

a. " Thin " wall in *Wentzelella* (*Wentzelella*) *regularis;*
b. Moderately " thick " wall in *Wentzelella* (*Wentzelella*) *osobudaniensis*, etc. c & d. Very " Thick " wall of *Wentzelella* (*Szechuanophyllum*) *kitakamiensis*.
e. Note the presence of " canal " in " thick " wall of *Wentzelellites senni*.



Text-figure 7

Diagrams showing the difference of wall thickness with reference to the development of lonsdaleoid dissepiments.

a. *Wentzelella* (*Szechuanophyllum*) *kitakamiensis;*
b. *Polythecalis denticulatum;* c. *Wentzelophyllum kueichowense;*
d. *Wentzelophyllum chaoi.*

the role of compensation of wall in mural septa must be especially highly estimated in this coral.

The next is a rather simple wall as a member of septal wall, in which the wall is also essentially thin but is decorated by mural septa of a low triangular form. Besides, the mural septa are not completely jointed but a little apart from each other. In other words, the stereozone made of the septal wall is only weakly developed in this type. Such a wall is typically developed in rather primitive forms of *Wentzlella*, *W. osobudaniensis* IGO for instance.

Other walls may be grouped as septal wall composed of elongate or high mural septa. Some of which provides walls with mural septa, being of a long or high triangular form, while, there are others with elongated hexagonal or spatulate mural septa. For instance, *Wentzelella* (*Szechuanophyllum*) *szechuanensis* is provided with mural septa of high triangular form, while, *Yokoyamaella* (*Yokoyamaella*) *yokoyamai*, is provided with a spatulate form. Further, *Wentzelloides maiyaensis* has an elongated hexagonal mural septa.

It must be noted that in some septal walls, the original thin wall is still clearly distinguished from the structure of mural septa, although it is very thin. However in most septal walls, mural septa become so thick and are so entirely jointed with each other, that the original thin wall between the neighbouring corallites is almost undiscernible. This is especially true in the septal wall with high or elongated mural septa, in which the boundary line between the neighbouring corallites becomes obsolete.

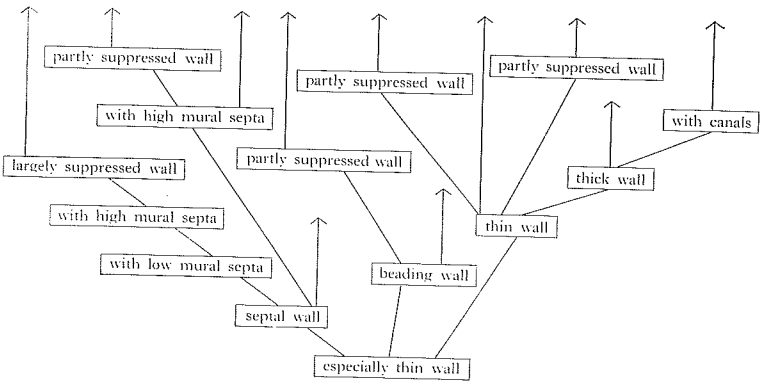
In this type of coral, a particular thinness of the original wall is doubtless, and such a coral must be especially worthy of note in that its septal wall is sometimes or frequently broken, although it is thickly decorated by mural septa; that is to say, the wall is partly or nearly entirely suppressed.

For instance, *Wentzelellites senni* sp. nov. has a septal wall, sporadically vanished and *Wentzelloides maiyaensis* has a wall being frequently suppressed. *Polythecalis* originally provides a septal wall, but sometimes shows a marked lacking of wall.

Such a suppression of wall is not entirely lacking in the walls among thin wall, or in the thick wall or beading wall above defined. However, it more frequently occurs in the septal wall with high mural septa. This fact may be worthy of note.

Further, the septal wall with high mural septa is more prevalent in the stratigraphically lower corals, although it does clearly show a more complicated nature than in the thin or thick wall.

Such older corals with high mural septa which are partly or largely suppressed may have, however, evolved from a common ancestor with a very thin wall. The phylogenetic relation of various types of walls can be accordingly tabulated as follows:



2) EVOLUTIONAL TRENDS

Although certain earlier forms belonging to Waagenophyllidae have been found from the Middle Carboniferous deposits of the Weiningian formation in South China, most species of waagenophyllid corals have been known only from the Permian. Hence, little is still known concerning the Carboniferous Waagenophyllids. However, it may be highly probable that waagenophyllid corals were already variously branched or differentiated into many bioseries prior to the Permian. That is to say, the diversity of waagenophyllids in the early Permian could be the results from the vigorous branching in the Middle and Upper Carboniferous age.

The ancestral form of Waagenophyllidae cannot be pointed out with certainty at present, but in any case it did exist and might have first made its appearance probably in the early Carboniferous age, from which many forms had already branched off as distinct genera from each other, during the Middle and Upper Carboniferous age.

Unfortunately we are unable to trace with certainty their evolutional course

regarding the earlier forms of waagenophyllids, mainly through their rare occurrence in the Carboniferous deposits.

Accordingly it may be rather natural, that Waagenophyllidae gives the impression as being polyphyletic in origin as a whole, in so far as the Permian forms are concerned.

Hence, the evolutional trends here termed do not cover all forms of Waagenophyllidae. In fact, such changes can only be traced with assurance in certain genera or subgenera. Further, certain types of structure show a progressive alternation in some forms but retrogressive in other forms. For instance, lonsdaleoid dissepiments are lacking in the earliest forms of *Wentzelella* but the structure become well developed in the higher forms; while a reverse change is traceable in *Ipciphyllum* or *Yokoyamalla*.

A brief summary of the major changes observed in certain groups of waagenophyllids through their evolutional course will be described below.

TERTIARY OR MORE ORDERS OF SEPTA

The presence of three or more orders of septa are quite unique and is a remarkable nature in waagenophyllid corals, although not all of the forms belonging to Waagenophyllidae provide them.

Generally speaking, no Carboniferous forms actually possess such higher orders of septa. Further, almost entirely fasciculate forms of Waagenophyllidae seem to lack tertiary and quarternary septa.

On the contrary, tertiary and still higher order of septa are especially prevalent in most solitary and massive forms. For instance, all solitary forms except *Pavastehphyllum* possess tertiary septa. Moreover, quarternary septa first appear to develop in certain advanced solitary forms with tertiary septa, viz. in the stragraphically higher species.

In other words such Sakmarian forms as *Iranophyllum* (*Laophyllum*) *nakamurai* sp. nov. has tertiary septa only, besides normal major and minor ones, while in slightly higher forms such as *Iranophyllum* (*Iranophyllum*) *tunicatum* IGO quarternary septa first appear.

A similar case is also observable in the genus *Wentzelella*. In the earliest from of *Wentzelella* (*Pseudoschwagerina* zone) only three orders of septa have been found, to date. The tertiary septa here are incipient in development. In a still higher form, such as *Wentzelella osobudaniensis*, quaternary septa first appeared but they were still not numerous. In stratigraphically still higher forms, for instance, *Szechuanophyllum szechuanensis* (HUANG) (*Parafusulina* zone) and *S. kitakamiensis* (YABE et MINATO) (*Neoschwagerina*-zone) quarternary septa become numerous, besides major, minor and tertiary septa.

Thus, the appearance and progressive modification in the order of the septa, can be regarded to be a most definite evolutional trend found in Waagenophyllidae.

To be sure, the earlier species of Waagenophyllidae, including the imaginary ancestral form of the Lower Carboniferous did not possess any higher order of septa, except for major and minor ones. In the course of evolution, certain forms began to possess tertiary septa. This was in the early Permian age. Then quarternary septa became developed in more advanced forms as above stated, and they became prevalent in increasingly specialized forms of a later age.

Further, septa generally increase in number, when corallites tend to become larger; so that, increasing of septa can be also viewed to be an evolutional trend for each genus.

DEVELOPMENT OF CLINOTABULAE AND ELONGATE-DISSEPIMENTS

As it was stated, the clinotabulae structure is not confined to Waagenophyllidae, further elongate dissepiments are evidently developed in *Huangia*, the earliest form of Waagenophyllidae hitherto known. Perhaps such dissepiments may also develop in certain forms of " *Stylidophyllum* " and allied forms of the Lower Carboniferous age but they are only incipient and sporadically developed.

Moreover, combination of these two skeletal elements seem to show a progressive modification with certainty in nearly every branch of the Permian Waagenophyllidae. Hence, development of these two structures can be viewed to be also an important evolutional trend in this group of corls.

It is certain that elongate dissepiments are in general smaller in size, and sporadically developed in relatively earlier forms in every genus, but they become increasingly larger and numerous in later forms. Finally the elongate dissepiments seem to completely replace the normal, globose dissepiments in certain forms. For instance, *Waagenophyllum* (*Waagenophyllum*), the earliest form (*W. hudsoni*) for example, possesses relatively less numerous elongate dissepiments as compared against normal dissepiments, but in higher forms such as *Waagenophyllum indicum* and *W. virgalense* develop more numerous elongate dissepiments, although a single row of normal dissepiments are still observable in some corallites.

Also *Huayunophyllum*, the stratigraphically highest waagenophyllid seems to be nearly entirely filled with large elongate dissepiments in its dissepimentarium.

Hand in hand, long clinotabulae are more prevalent in most waagenophyllids indicating a relatively higher stratigraphical horizon.

At least, in regard to *Waagenophyllum* in a strict sense, changes in the ratio of development of elongate dissepiments to normal dissepiments seems to be a good criterion to correlate formations in widely separated areas, where the mentioned corals are found, because the changes are observed to appear in the same relative geologic sequence.

LONSDALEOID DISSEPIMENTS

Generally speaking, lonsdaleoid dissepiments are found in nearly all the

genera belonging to Waagenophyllidae, although in certain species of some genera these structures are quite rudimentary or almost lacking.

However, the mentioned dissepiments can be concluded to be more prevalent in the earlier forms in general in comparison to the higher forms.

Among fasciculate forms for example, lonsdaleid dissepiments are well developed in such older genera as *Huangia*, and *Akagophyllum*, but they are ill developed in *Pseudohuangia*, *Chihsiaphyllum* and *Heritschiella*, while the structure is almost lacking or only rudimentary in *Waagenophyllum* in a wide sense.

Also among massive forms, lonsdaleoid dissepiments are especially prevalent in such older genera as *Chusenophyllum*, *Polythecalia*, *Wentzelophyllum*, and *Yokoyamella*, but rather ill developed in such younger forms as *Parawentzlella*.

Further, a similar case can be seen in the genus *Ipciphyllum*. In this genus, earlier species (*Parafusulina* zone) have more well developed lonsdaleoid dissepiments than the later forms (*Neoschwagerina* zone), although there are cartain older species (also in the *Parafusulina* zone), in which lonsdaleoid dissepiments are rather poorly developed.

Thus, the lonsdaleoid dissepiments may be concluded to be rather retrogressive trend in waagenophyllids through the ages.

An objection for this statement is, however, found in the genera *Wentzelella* and *Iranophyllum* (*Laophyllum*).

Of these, in the former, the earliest species nearly lacks lonsdaleoid dissepiments, but the structures seem to gradually develop in the later forms. Further, in *Szechuanophyllum* which may have directly evolved from *Wentzelella* (s. str.) well developed lonsdaleoid dissepiments are found. In *Laophyllum*, lonsdaleoid dissepiments are fairly well developed in the Sakmarian species, but the structures seem to be more pronounced in the forms of later ages.

SUPPRESSION OF WALLS

Among cerioid forms of Waagenophyllidae, stratigraphically higher forms seem to have a tendency in which walls are partly or largely disappearing or at least, the higher forms in general are more pronounced in their suppression of walls as compared with the primitive forms in each genus.

Wentzelella for instance, has corallites in which walls are perfect and do not show interruption or discontinuity, while still higher forms such as *Szechuanophyllum szechuanensis* or *S. kitakamiense* have partly suppressed walls, and are replaced by septa or lonsdaleoid dissepiments.

In the genus *Wentzelloides*, which may be another decendant from *Wentzelella* such an inclination of losing walls seems to be more pronounced. Also *Wentzelellites* and *Lonsdaleiastraea* may be still another branches from *Wentzelella*. The walls of these genera are also much suppressed and sometimes are only locally retained.

Polythecalis is essentially characteristic in showing a remarkable suppression of walls, and in this regard this genus is more progressive than *Wentzelophyllum*. Geologically speaking, *Wentzlelophyllum* seems to have appeared prior to *Polythecalis*.

Further, *Chuseonophyllum* shows to have a later geological distribution than *Polythecalis*, from which *Chusenopyllum* is only distinguishable by its complete disappearance of walls.

Accordingly, suppression of walls can be regarded to be one of the progressive trends found in Waagenophyllidae.

In this regard, the senior author once held a view in 1955 that such a bioseries from *Wentzelella* to *Lonsdaleiastraea* or *Wentzelloides* through canaliferous *Wentzelella* in the degree of suppression of walls may be expected.

So-called canals or gaps in walls observable in the genus *Parawentzelella* FONTAINE, cannot be viewed to be the mere results of suppression of walls, as FONTAINE stated in detail. Accordingly such bio-series seem to be probably no longer tenable.

Nevertheless, there exists such species as *Paraipciphyllum elegantum* WU and *P. hudsohi* sp. nov. in which canals are not developed but walls are partly suppressed. Moreover, those two species show a strong affinity to *Parawentzelella* with thick walls in general appearance of corallites as compared with *Wentzelella*. Thus the intermediate nature of these two forms between true cerioid and plocoidal forms cannot be denied.

In any case, the plocoidal nature seems to appear in a more later stage than the earlier for each genus, and suppression of walls may be a progressive evolutional trend.

SIZE OF AXIAL STRUCTURE

No remarkable differences exist in the axial structure for all of the species belonging to Waagenophyllidae with few exceptions. However, in the earlier forms, in the genus *Huangia* for instance and more primitive species belonging to *Akagophyllum* and *Pseudohuangia*, the axial structure generally occupies only a narrow space. Such a tendency is discernible in the earlier species of *Waagenophyllum*, also.

While in the advanced genera and more specialized forms of *Waagenophyllum* a larger axial structure is seen.

WIDTH OF TRANSVERSE TABULAE

In contrast to the size of axial structure, the transverse tabulae are generally wider in more primitive forms of Waagenophyllidae than the higher forms. For instance, *Pseudohuangia*, *Akagophyllum* and *Huangia*, especially the earlier forms of these genera have a wider transverse tabulae while the more advanced genera

and species belonging to *Waagenophyllum* have a narrow transverse tabulae. This is why the tabularium in advanced forms is largely or nearly entirely occupied by clinotabulae, besides transverse tabulae. Hence, the decreasing of width in transverse tabulae can be regarded as an evolutional trend in Waagenophyllidae.

SIZE OF CORALLITES

As far as the size of waagenophyllids are concerned little change between the older genera and younger ones are seen. In spite of this, the earlier species for each genus seems to have smaller corallites in general, in comparison to the later species. At least it is quite true, that relatively larger forms for each genus are found among stratigraphically higher species, instead of lower ones. Thus, the trend that corallites become larger may also be evolutional.

3) A BRIEF SUMMARY ON PERMIAN STRATIGRAPHY IN JAPAN

Fossiliferous Permian deposits are typically developed in the southern part of the Kitakami mountains in northeastern Honshu, Japan. They are divisible into three major groups in the ascending order: Sakamotosawa (Sakamotozawa) series, Kanokura series and Toyoma series.

Of these, the Toyoma series is composed of thick slates intercalating sandstones, besides conglomerates. This formation is almost barren of fossils, except for a few molluscan and molluscoidal remains found sporadically in certain horizons.

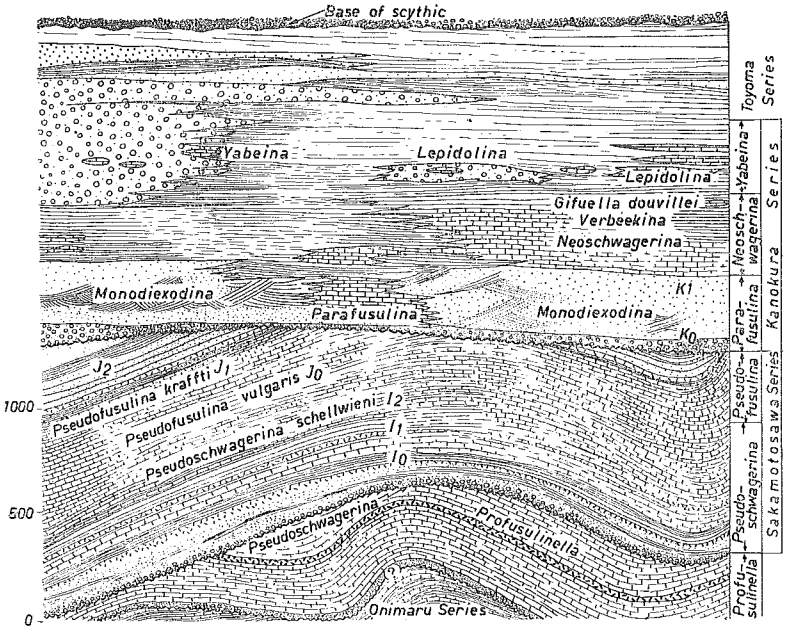
On the contrary, the Sakamotosawa and Kanokura series are fossiliferous. Both of them are very thick and mainly consist of limestones, slates, sandstones and lesser amount of pyroclastic sediments besides conglomerates.

The Sakamotosawa series unconformably lies on the Nagaiwa series, the lowest Middle Carboniferous or possibly equivalent to the Upper Namurian to Bashkirian in age.

As described in the previous paper (MINATO, TAKEDA, KAKIMI and KATO, 1959), the Nagaiwa series dominantly consits of limestones. The lower half is defined as the Sabukura stage in which *Millerella*, *Dibunophyllum bipartitum konincki* (EDWARDS et HAIME), *Dibunophyllum* sp., *Chaetetes nagaiwaensis* MINATO, *Thysanophyllum aseptatum* DOBROLYUBOVA, *Sciophyllum japonicum* MINATO et SAITO and *Syringopora* sp. are found. While, the upper half, designated as the Yomogibata stage is also prevalent in similar fossils as in the lower half, but the upper formation is further characterized by the presence of such fusulinid foraminifera as *Profusulinella*, *Pseudostaffella*, *Ozawainella and Eoschubertella.*

Now, the Sakamotosawa series may be diagramatically shown in its lithological sequence in fiig. 8, namely it begins with basal conglomerate called Sakamotosawa conglomerate, then comes sandstones and slates in alternation, inter-

calating thin graphite layers with land plant remains, further it is followed upwards by thin schalstein (basic tuff), sandstone, black slate in alternation with thin layers of liparitic tuff.



Text-figure 8
Geologic section of the Permian and underlying formations of the Kitakami mountains. I_0, I_1, I_2, J_0, J_1, J_2, K_0, and K_1 mean the more important fossil bearing members (see text).

Then, very thick but well bedded limestones come to rest on the above mentioned alternation. Fossils are richly found in limestones, especially fusulinid foraminifera are prevalent in the lower part of the limestones. This is the so-called I_2 horizon of the former paper (MINATO et al. 1954). The leading forms are: *Pseudoschwagerina schellwieni* HANZAWA, *Pseudoschwagerina* (*Zellia*) *nunosei* HANZAWA, *Acervoschwagerina* sp., *Nipponitella explicata* HANZAWA, *Nipponitella auricula* HANZAWA and *Nipponitella expansa Hanzawa*. Besides *Durhamina kitakamiensis* MINATO et KATO (MS) and " *Spirifer* " cf. *nikitini* can be regarded to be the characteristic elements of this horizon.

Non-calcareous members lying below the I_2 horizon of the Sakamotosawa series are generally very thick everywhere, although they are locally different in thickness and stratigraphically not yet satisfactorily studied; nevertheless at least two important fossil bearing beds may be enumerated. These are found at relatively lower and higher parts of the non-calcareous group. They are the I_0

and I_1 horizons respectively, described in the former occasion (MINATO et al., 1954). Both of them are abundant in brachiopods and molluscan fossils; in I_0 *Chonetes*, *Productus*, and *Acanthopecten* are especially rich in species and individuals, while in I_1 *Bellerophon*, *Aviculopecten Rhynchonella* of large sized shells are occasionally found. *Lophophyllidium suetomii* MINATO, once described by the senior author is one of the good horizon indicators of I_1.

Now the geologic age of the non-calcareous group has been long discussed by Japanese palaeontologists. Some believe it to be upper Carboniferous, because *Pseudoschwagerina* has been found only from the limestone member but not from the underlying group.

On the contrary, the senior author believes that the noncalcareous group underlying the *Pseudoschwagerina* limestone can be also Permian in age, because brachiopod fossils forund from I_0 and I_1 beds strongly possess Permian aspects in general.

Among them *Lyttonia* sp. was collected by Y. ONUKI (1937). Further, the senior author once succeeded in finding *Pseudoschwagerina* sp. from the very base of the Sakamotosawa conglomerate. It was unexpectedly discovered in the calcareous matrix of conglomerate cropped out at Amakaze, northwest of the Setamai town. It is accordingly absolutely evident that not only the limestone members but also the non-calcareous group of the Sakamotosawa series is Lower Permian in age.

As a representative of waagenophyllid corals, a single specimen of *Wentzelella* was once collected by T. YOSHIDA (in MINATO, 1955) from the lowest part of the non-calcareous group of the Sakamotosawa series cropped out at Yamamoto in Esashi-gun, hence it comes from I_0 horizon in rough estimation. Details on this coral will be given in a later chapter.

Besides this *Wentzellella*, *Iranophyllum* (*Laophyllum*) *nakamurai* sp. nov. was lately found by us as the representative of waagenophyllid of this horizon of the Sakamotosawa series.

Incidentally, the limestone of the Sakamotosawa series is fairly thick and may be palaeontologically divisible into two mjor groups. The boundary cannot be easily pointed out in field, because the limestones are quite monotonous in lithologic nature as a whole, yet *Pseudoschwagerina* and *Nipponitella* are only found in the lower half of the limestones, and they completely disappear in the upper half. *Pseudofusulina vulgaris* var. *globosa* is detected around the middle portion of the limestones, and *Pseudoschwagerina* seems to range almost up to this horizon (J_0 horizon), but not beyond this.

The characteristic horizon indicators of the upper Sakamotosawa series are found close to the top of the limestones, which was named J_1. From this horizon *Michelinia* (*Michelinopora*) *multitabulata* YABE et HAYASAKA, and *Yatsengia kabayamaensis* MINATO were described. Further, *Pseudofusulina kraffti* and " *Para-*

fusulina" are found from J_1.

TORIYAMA (1952) once identified some fusulinids from the horizon J_1 to *Parafusulina gigantea* and *Parafusulina japonica*. But this identification seems to be rather doubtful as he was also uncertain about his determination.

Tracing the sequence of beds further upwards from the limestones, sandstones intercalating thin acidic tuffs and flows are found. These are the highest members of the Sakamotosawa series, which are in turn covered by basal conglomerate of the Kanokura series, Middle Permian in age.

The sandstones stated above are the horizon from which K. NAKAMURA (1959) described some brachiopod fossils as representatives of the Lower Sakamotosawa series. Thus his designation on the horizon of the brachiopod fauna must be revised to the Upper Sakamotosawa series here, instead of the Lower. This horizon can be designated here as J_2.

The stratigraphical relation between the Sakamotosawa and Kanokura series has not been yet settled with certainty, since the very base of the latter is disturbed by faulting nearly everywhere examined, but the presence of unconformity between them is almost certain.

The basal part of the Kanokura series is composed of conglomerates and sandstones in alternation: then thick, coarse grained sandstones with thin layers of slate come to rest on the basal member. This sandstone formation contains long, aberrant form of fusulinid foraminifera together with a number of brachiopod fossils everywhere. The aberrant fusulinid has long been believed by many Japanese paleontologists to be closely related to *Parafusulina wanneri*, which is however, according to FUJIMOTO specifically distinct from the latter. This was named *Parafusulina matsubaishi* by him. The literal translation of *matsubaishi* is pine-needle-stone in Japanese, and this name has been in long use by the inhabitants there to this fossil. Instead of the generic name *Parafusulina*, *Monodiexodina* would be, however, better for this species, because the structure of shells of this species is closer to the nature of *Monodiexodina* than *Parafusulina*. The genus *Monodiexodina* was first established by SOSNINA in 1956, based on *Parafusulina sutschanica* found at Sutschan in the coastal region of the Russian Far East.

The brachiopods are dominant both in species and individuals: among them, the following species may be enumerated, which seem to be stratigraphically more important. They are: *Lyttonia nobilis* WAAGEN, *Lyttonia richthofeni* (KAYSER), *Dictyoclostus flemingi* (SOWERBY), *Dictyoclostus gratiosus* (WAAGEN), *Cancrinella villiersi kozlowskiana* FREDERICKS, *Chonetes deplanata* WAAGEN, and *Isogramma paotechowensis* GRABAU et CHAO.

Immediately on the sandstone formation stated above limestones come to rest in general. At Iwaizaki, about 8 km south of the town of Kesennuma for instance, the fossiliferous sandstone formation with *Monodiexodina matsubaishi* is directly covered by limestones of about 100 mm in thickness, in the lower half

of which schwagerinids, parafusulinids and pseudofusulinids are abundantly found (MORIKAWA et al. 1958).

On the contrary, *Gifuella douvillei* (OZAWA) and *Verbeekina* sp. are found from the relatively higher horizon of the limestones there. Further, *Lepidolina* are abundantly found at a slightly higher situated horizon of the limestone. Thus, the limestone developing at Iwaizaki can be correlated with certainty to the zones ranging from the Upper *Neoschwagerina* zone until the Lower *Yabeina* zone at Akasaka, Central Japan which will be described in detail later.

The Problem is how to correlate the lower half of the limestones developing at Iwaizaki, and the underlying sandstone formation with *Monodiexodina matsubaishi*.

As it will be later described, limestones rich in fusulinid foraminifera are typically developed at Akasaka, Central Japan, where the following faunal zones are established by HONJO (1959) in the ascending order; viz. *Minoella nipponica* zone, *Pseudodoliolina ozawai* zone, *Neoschwagerina craticulifera* zone, *Yabeina ozawai* zone, *Gifuella douvillei* zone and *Yabeina globosa* zone.

At Iwaizaki, there seems no remarkable stratigraphical break between the upper half of the limestones bearing *Gifuella* and *Verbeekina* and the underlying lower half of the limestone. Also the very base of the limestones appears to cover conformably the sandstone formation with *Monodiexodina*. Hence the lower half of the limestones seems to be correlatable to the zones lower than *Yabeina ozawai* or *Neoschwagerina craticulifera* at Akasaka. Yet no reliable horizon indicators have been found among the fusulinid foraminifera from the lower half of the limestones at Iwaizaki. There is neither *Neoschwagerina* nor *Pseudodoliolina* or *Minoella* in the lower part of the limestones developing at Iwaizaki*.

Meanwhile, such waagenophyllid corals as *Parawentzelella* (*Parawentzelella*) *iwaizakiensis* (YABE et MINATO), and *Waagenophyllum* (*Waagenophyllum*) *virgalense* (WAAGEN et WENZEL) have been found from the lower half of the limestones at Iwaizaki. Further, three species of *Parawentzelella* besides *Iranophyllum tunicatum* IGO were very recently discovered from the same horizon there. All those corals seem to indicate the *Neoschwagerina* zone with a high possibility; that is to say *Neowchwagerina craticulifera* zone. In other words, these corals are younger than *Minoella nipponica* and older than *Gifuella douvillei*.

Incidentally, at Kattisawa (Kitchisawa), some 2 km west of the town Setamai, similar limestones seemingly correlatable to the limestones developing at Iwaizaki

* S. MABUTI (1936) reported that *Yabeina* sp. was found in the lower members of the limestones now in question at Iwaizaki. This seems to be highly questionable. We have endeavoured to find the so-called " *Yabeina* " from this horizon for a long time without any success. Also MORIKAWA and others (1958) conducted a detailed survey at the same locality in cooperation with many geologists, but they were also unable to unearth " *Yabeina* " from the same limestone especially from its lower half.

are also well developed, where the limestones directly cover the sandstone formation with *Monodiexodina* without any stratigraphical break.

It is this limestone that *Wentzelella* (*Szechuanophyllum*) *kitakamiensis* YABE et MINATO was found. Further, the senior author described " *Waagenophyllum indicum* var. *usuginuensis* MINATO " from the same limestone. The latter of which is now regarded by us to be synonymous with the WAAGEN and WENTZEL species, although the Kitakami specimens are slightly larger in corallites and have numerous septa.

Now, the two corals above mentioned were actually found from different localities, slightly apart from each other, but they seem to denote nearly the same horizon.

In addition, *Neoschwagerina* sp. was newly found from the same limestone, after the mentioned waagenophyllid corals were described. The limestone is very thick at Kattisawa (Katchisawa) and highly folded, and the exact stratigraphical relation between the mentioned *Neoschwagerina* and the waagenophyllid corals is hardly determinable. Nevertheless, waagenophyllid corals there can be regarded to be the elements of the *Neoschwagerina* zone in rough estimation. The mentioned *Neoschwagerina* is based on an obliquely cut single specimen, which was unexpectedly found in a slide, but it appears to be not as primitive as *Minoella* or highly specialized as *Gifuella*. Secondly, the limestone developing at Kattisawa, though highly complicated in geological structure, is observed with certainty to cover the sandstone formation with *Monodiexodina* and is covered by a formation comprising thin limestones and black slates in alternation. It is this alternation from which the senior author found an extraordinarily large sized fusulinid foraminifera. This was named by TORIYAMA as *Lepidolina gigantea*. Accordingly, the matter seems to become manifest, that the waagenophyllid corals found at Iwaizaki and Kattisawa may possibly denote the *Neoschwagerina craticulifera* zone in rough estimation.

In this regard, the former description of the senior author on the geological horizon of waagenophyllid corals of the Kanokura series must be revised, because he once stated it to be the *Yabeina* zone instead of the *Neoschwagerina* zone.*

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* In fact, " *Waagenophyllum indicum* var. *usuginuensis* " was found not only at Kattisawa, but also at Sammai-yashiki, Higashiiwaigun, far westward from the type locality for this coral. To be exact, the second specimen was discovered from the Usuginu-conglomerate cropped out there. The specimen was composed of a single corallum embedded in a limestone matrix of conglomerate without any other fossils in association. However, M. NODA (1934) once reported the occurrence of some fossils which were found almost at the same locality from the Usuginu conglomerate formation. He listed the following fossils there : *Neoschwagerina douvillei*, *Yabeina hayasakai* and *Waagenophyllum indicum* (= *W. akasakense*). According to him, all of those fossils were found in the same limestone.

Although *Waagenophyllum indicum* is specifically distinct from *akasakenses*, he seemed to believe its synonymity. Perhaps, his specimen had slightly larger corallites in which the walls

Now, tracing the sequence upwards from the alternation of black slate and limestone with *Lepidolina*, heavily bedded black slate of the so-called Toyama type are found. Further upwards, comes rather thin conglomerate, sandstone and black slate in alternation. The conglomerate is also locally fossiliferous, especially in its lower member. To be exact, the conglomerates are locally very calcareous in their matrix in which higher forms of fusulinids, *Lepidolina* spp. for example are found in a few localities.

This conglomerate formation in an upward direction has sandstones which are generally covered by a thick slate formation.

Now, in certain regions of the Kitakami mountains, conglomeratic facies is especially prevalent in the Permian. For instance, in the southwestern part of the mountains, the *Neoschwagerina* zone, especially in its upper horizon and the *Yabeina* zone, seem to be largely replaced by thick conglomerates with granitic pebbles. This is the so-called Usuginu formation, in which the matrix of conglomerate is also locally calcareous and fossiliferous. The senior author once found two forms of waagenophyllid corals, besides *Yabeina* sp. at Yamasaki (Yamazaki), Maiyamachi, Tome-gun, Miyagi prefecture. They are *Wentzelloides maiyaensis* YABE et MINATO and *Waagenophyllum virgalense* WAAGEN et WENTZEL. Hence, *Wentzelloides* indicates the *Yabeina* zone with certainty, whereas *Waagenophyllum virgalense* must be regarded to range from the *Neoschwagerina* zone up to *Yabeina* zone, because it is also found at Iwaizaki from the lower half of the limestones developing there. In the Kitakami mountains, the Toyoma series is entirely lacking in fusulinid foraminifera or waagenophyllid corals.

Waagenophyllid corals are therefore distributed in the southern Kitakami mountains from the lowest part of the Sakamotosawa series up to the top of the Kanokura series. Stratigraphically speaking, they are in distribution from the

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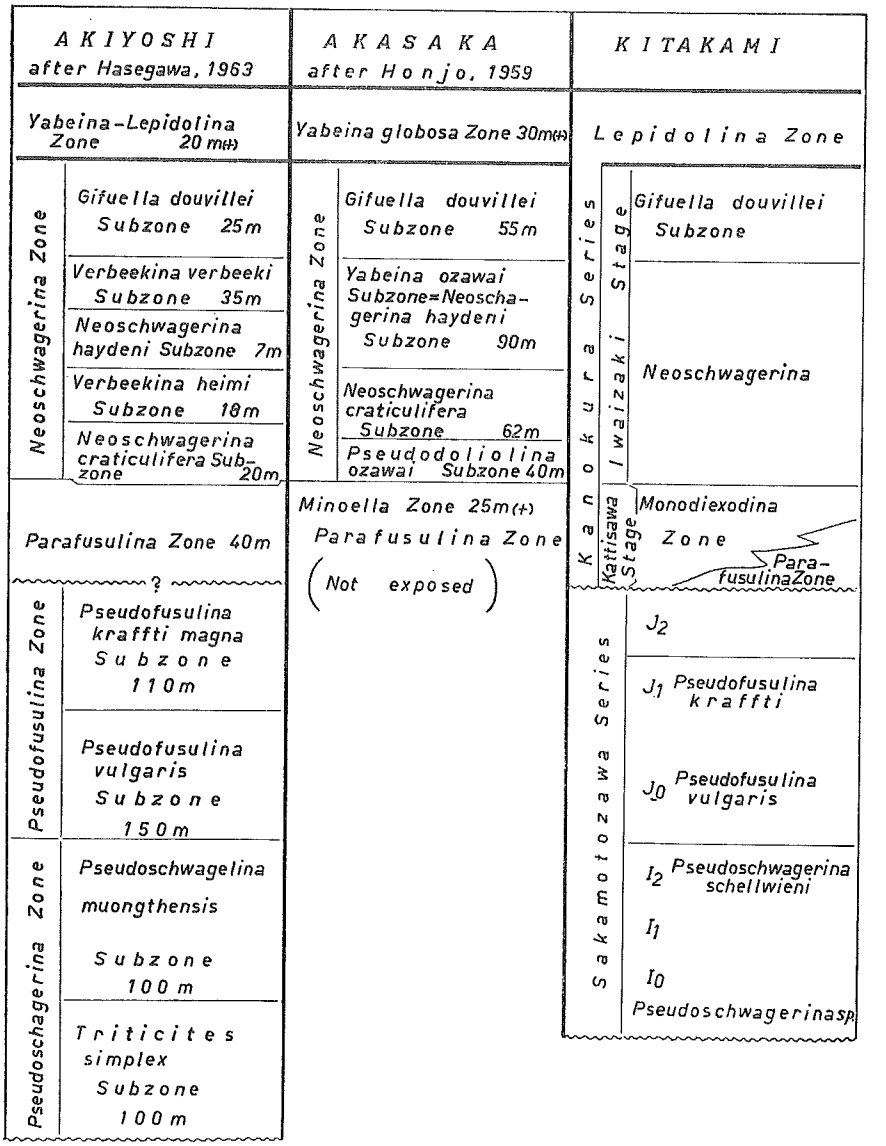
may have been a little thicker than the typical *indicum*. If this is so, the specimen listed by NODA seems to be the same as the corals called by the senior author under the name of *W. indicum* var. *usuginuensis*.

This species was found at Kattisawa without any other fossils in association, but it is not difficult to believe that the same waagenophyllid was found at Sanmai-yashiki. Because *Waagenophyllum indicum* was found at nearly the same locality. It is of course an open question whether the senior author's specimen was spotted from exactly the same horizon at the same locality where NODA's material was collected. Nevertheless the probability is high. This gave the auther ground to denote *Waagenophyllum indicum*=*W. indicum* var. *usuginuensis* as a representative of the *Yabeina* zone, instead of *Neoschwagerina*. Hence, *Wentzelella kitakamiensis* was once described to denote the *Yabeina* zone, also.

However, the matter is now manifest, that at least *Wentzella kitakamiensis* is an element of the *Neoschwagerina* zone, and *Waagenophyllum indicum* var. *usuginuensis* (=*W. indicum*) is found from the *Neoschwagerina* limestone at Kattisawa, but the same species has a possibility to have been found also from the *Yabeina* zone at Sanmai-yashiki, that is to say, this species seems to range from the *Neoschwagerina* zone up to the *Yabeina* zone.



Text-figure 9

Correlation chart of the Permian formations developed in the Akiyoshi district in Southwestern Honshu, Akasaka district in Central Honshu and Kitakami district of Northeastern Hoshu.

Pseudoschwagerina zone up to the top of the *Yabeina* zone.

In the Kitakami mountains, no evidence of the *Yabeina globosa* limestone has been found. The limestone with *Gifuella douvillei* fauna is observable at places in the Kitakami district to be directly covered by the limestone with *Lepidolina*. This limestone is also overlain by slate and conglomeratic deposits with limestone lense bearing *Lepidolina*.

Hence, the equivalent horizon in the Kitakami mountains to the *Yabeina globosa* limestone at Akasaka, Central Japan seems to be largely replaced by the formation with *Lepidolina*. It seems almost impossible to conclude that the *Yabeina globosa* zone is lacking in the Kitakami mountains or that the *Yabeina globosa* zone of Akasaka is stratigraphically lower than the *Lepidolina* zone of the Kitakami mountains.

At Akasaka, Central Japan, the *Yabeina globosa* zone is represented by fairly thick limestones, some 200 m in thickness. Such a thick formation can be hardly believed to be lacking in the sequence of the Permian in the Kitakami mountains. In spite of our long and fairly detailed survey in field, no stratigraphical breaks have ever been detected between the *Gifuella douvillei* zone and the overlying *Lepidolina* zone. In all probability, the formation with *Lepidolina* accordingly seems to be contemporaneous with the *Yabeina globosa* zone at Akasaka, as stated above.

Next, we should like to dwell on the Permian stratigraphy at Akasaka, where S. HONJO lately made a very detailed biostratigraphical study.

Akasaka, situated in the Gifu Prefecture, central Honshu, Japan, is one of the most classical fields for the Japanese Paleozoics, since the early days of GOTTSCHE's work (in W. GÜMBEL 1874), followed by YABE (1901), DEPRAT (1941) and OZAWA (1927).

According to HONJO (1959), the limestones developing at Akasaka are divided in the descending order as follows:

Yabeina zone approximately 200 m in thickness.

Contained fusulinids are: *Yabeina globosa* (YABE), *Yabeina katoi* OZAWA and *Neoschwagerina minoensis* DEPRAT.

Neoschwagerina zone some 272 m in total thickness.

Gifuella douvillei subzone, about 55 m with *Gifuella douvillei* (DEPRAT).

Yabeina ozawai subzone, about 90 m.

Dominant forms are: *Yabeina ozawai* HONJO (= *Neoschwagerina margaritae* OZAWA, non DEPRAT), *Gifuella amicula* HONJO, *Gifuella gifuensis* HONJO, *Neoschwagerina colaniae* OZAWA, *Metaschwagerina ovalis* MINATO et HONJO and *Verbeekina sphaera*.

HONJO once recorded the occurrence of *Pseudoschwagerina* spp. from this subzone, but this seems to have been a mistake. Instead of *Pseudoschwagerina*,

Pseudofusulina should have been listed in this case.

Neoschwagerina craticulifera subzone, 62 m in thickness, in which the following fusulinids are more prevalent: *Neoschwagerina craticulifera* (SCHWAGER), *Neoschwagerina irregularis* HONJO and *N. haydeni* (DOUTKEVITCH and KHAVAKOV).

Pseudodoliolina ozawai subzone, about 40 m in thickness in which neoschwagerinids are hardly detectable. On the contrary *Pseudodoliolina ozawai*, *Verbeekina verbeeki*, *V.* cf. *heimi* are abundant. Here HONJO also erroneously listed *Pseudoschwagerina* spp. from this subzone, while they were actually *Pseudofusulina*.

Minoella nipponica subzone, about 25 m.

This subzone is characterized by the presence of very primitive neoschwagerinids like *Minoella eonipponica* HONJO, *Minoella nipponica* (OZAWA), *Neoschwagerina simplex* OZAWA and *Neoschwagerina sphaerica* (M.-MACLAY). Also *Verbeekina minatoi* HONJO and *Pseudodoliolina ozawai* YABE et HANZAWA are not infrequent. In this subzone HONJO also recorded the occurrence of *Pseudoschwagerina* spp., but the generic name for them should be revised as *Pseudofusulina*. According to HONJO, corals are extremely rare along his survey route by which he hoped to determine the sequence of the cocurrence of fusulinid foraminifera. A single exception was a coral, which was found by him from the *Neoschwagerina craticulifera* subzone. This is *Praewentzelella honjoi* nov. However, at least two other waagenophyllid corals are known from the limestones developing at Akasaka: namely *Waagenophyllum* (*W.*) *akasakense* (YABE), which is a good horizon marker of the *Yabeina* zone there, while *W.* (*W.*) *polyseptatum* MINATO is now known to occur from the *Neoschwagerina craticulifera* subzone up to the *Yabeina* zone.

Whereas in the Akasaka province, the Lower Permian cannot be observed except in the subsurface, an almost entire sequence of the Permian is well observable in the Akiyoshi province of Southwestern Honshu, where Dr. Y. HASEGAWA lately made a most detailed survey and collected fairly large number of waagenophyllid coral specimens from the Permian deposits. The Permian sequence established by him is as follows in descending order:

Limestone of the *Yabeina-Lepidolina* zone.....about 20 m.
Contained fossils are: *Lepidolina shiraiwensis* (OZAWA), *L. yasubaensis* (TORIYAMA), *Schwagerina* sp., and such waagenophyllid croals as *Akagophyllum hasegawai* MINATO et KATO, *Waagenophyllum* (*Waagenophyllum*) *pulchrum* HAMADA, *Ipciphyllum laosense* (PATTE) and *Pavastephyllum?* sp. besides *Yatsengia* cf. *ibukiense* MINATO and *Lophophyllidium?* sp.
Limestone of the *Neoschwagerina-Verbeekina* zone

Gifuella douvillei subzone ..... 25 m
Fossils: *Gifuella douvillei* (OZAWA), *Neoschwagerina* sp. and *Yokoyamaella* (*Maoriphyllum*) *ozawai* (MINATO)
Verbeekina verbeeki subzone..... 35 m
Fossils: *Verbeekina verbeeki* (GEINITZ), *Schwagerina* spp.,
Neoschwagerina haydeni subzone..... 7 m
Fossils: *Neoschwagerina haydeni* DOUTKEVITCH et KHABAKOV, *N. craticulifera* (SCHWAGER), *N.* cf. *colaniae* OZAWA, *N.* sp., *Gifuella gifuensis* HONJO, G. sp., *Pseudodoliolina pseudolepida* (DEPRAT), *P. ozawai* YABE et HANZAWA, *P.* sp. A., *Pseudofusulina gigantea* (DEPRAT)
Verbeekina heimi subzone ..... 18 m
Fossils: *Verbeekina heimi* THOMPSON, *V. verveeki* (GEINITZ), *Pseufofusulina edoensis* (OZAWA), *P. gigantea* (DEPRAT), *Afghanella schencki* THOMPSON, *A. ozawai* HANZAWA, *Pseudodoliolina* cf. *pseudolepida* (DEPRAT), *P. ozawai* YABE et HANZAWA.
Neoschwagerina craticulifera subzone ..... 20 m
Fossils: *Neoschwagerina craticulifera* (SCHWAGER), *N. irregularis* HONJO, *N. simplex* OZAWA, *N.* sp., *Parafusulina kaerimizensis* OZAWA, *Yatsengia* sp., and *Waagenophyllum* sp.
Limestone of the *Parafusulina* zone..... 40 m
Contained fossils are as follows: *Parafusulina kaerimizensis* OZAWA, *P. lutugini* (SCHELLWIEN), *P.* spp., *Pseudofusulina* sp., *Afghanella schencki* THOMPSON, *A. ozawai* HANZAWA and *Ipciphyllum laosense* (PATTE)
Limestone of the *Pseudofusulina* zone
Pseudofusulina kraffti magna subzone..... 110 m
Fossils: *Pseudofusulina kraffti magna* TORIYAMA, *P. yobarensis* (OZAWA), *P. lepida* (DEPRAT), *P.* cf. *edoensis* (OZAWA), *P.* cf. *vulgaris globosa* (SCHELLWIEN), *Schwagerina krotowi* (SCHELLWIEN), *S.* cf. *regularis* (SCHELLWIEN), *S.* cf. *kueichihensis* (CHEN), *S.* sp. A., *Misellina claudiae* (DEPRAT), *Nagatoella kobayashii* THOMPSON, *Schubertella kingi* DUNBER et SKINNER, *Staffella yobarensis* OZAWA, *S.* sp., *Akagophyllum yabei* MINATO et KATO, *A. akagoense* (OZAWA), *Yokoyamaella yokoyamai* (OZAWA)
Pseudofusulina vulgaris subzone..... 150 m
Contained fossils are as follows: *Pseudofusulina vulgaris* (SCHELLWIEN), *P. vulgaris globosa* (SCHELLWIEN), *P. vulgaris megaspherica* TORIYAMA, *P. globosa exilis* TORIYAMA, *P. watanabei* (OZAWA), *P. yobarensis* (OZAWA), *P.* cf. *ambigua* (DEPRAT), *Schwagerina satoi* (OZAWA), *S. etoi* TORIYAMA, *S.* cf. *krotowi* (SCHELLWIEN), *Dunbarin-*

ella cervicalis (CHEN), *D.* cf. *densa* TORIYAMA, *Triticites ellipsoidalis* TORIYAMA, *T.* spp., *Paraschwagerina akiyoshiensis* TORIYAMA, *P.* sp., *Schubertella kingi* (DUNBAR et SKINNER), *Yatzengia?* sp.

Limestone of the *Pseudoschwagerina* zone

Pseudoschwagerina muongthensis subzone.....100 m

Contained fossils are as follows: *Pseudoschwagerina muongthensis* (DEPRAT), *P.* sp. A. *Triticites simplex* (SCHELLWIEN). *T. ozawai* TORIYAMA, *T. montipara* ((EHRENBERG) MÖLLER), *T. pseudosimplex* CHEN, *T. biconica* TORIYAMA, *T. cullomensis* DUNBAR et CONDRA, *T. suzukii* (OZAWA), *T. haydeni* (OZAWA), *T. noinskyi paula* TORIYAMA, *T. tantula* TORIYAMA, *T. arctica* (SCHELLWIEN), *T.* cf. *ellipsoidalis* TORIYAMA, *T.* spp., *Dunbarinella?* sp., *Schwagerina* cf. *satoi* (OZAWA), *S. regularis* (SCHELLWIEN), *Paraschwagerina* cf. *akiyoshiensis* TORIYAMA, *Schubertella kingi* DUNBAR et SKINNER

Triticites simplex subzone.....100 m

contained fossils are as follows: *Triticites simplex* (SCHELLWIEN), *T. ozawai* TORIYAMA, *T. montipara* ((EHRENBERG) MÖLLER), *T. pseudosimplex* CHEN, *T. biconica* TORIYAMA, *T. cullomensis* DUNBAR et CONDRA, *T. suzukii* (OZAWA), *T. noinskyi paula* TORIYAMA, *T. arctica* (SCHELLWIEN), *T.* spp., *Quasifusulina longissima* (MÖLLER), *Schubertella kingi* DUNBAR et SKINNER, *Yabeiphyllum hagasakai* MINATO et KATO sp. nov. (MS), *Yatzengia?* sp., Cerioid coral indet. (*Yokoyamaella* sp.) and *Pseudoschwagerina* sp.

Limestone of the *Fusulina-Fusulinella* zone.....275 m

Contained fossils are as follows: *Fusulina akiyoshiensis* TORIYAMA, *F.* sp. A nov., *Fusulinella biconiac* (HAYASAKA), *F. itoi* (OZAWA), *F. bocki* MÖLLER, *F. chuanshanensis* (LEE et CHEN), *F. simplicata* TORIYAMA, *F.* sp. A nov., *F.* sp. *B* nov., *F.* sp. 3 nov., *F.* sp. D. nov., *F.* spp., *Eoschubertella obscura* (LEE et CHEN), *E.* spp., *Ozawainella* sp., *Nankinella* sp., *Staffella* sp., "*Clisaxophyllum*" *atetsuense* MINATO et NAKAZAWA, "*Styllidophyllum*" sp., *Pseudopavona* spp., *Chaetetiporella* sp., "*Dibunophyllum*" sp., "*Dibunophylloides*" *acystatum* KATO (MS), "*D*". *ofukense* (OZAWA), "*Lonsdaleiastraea*" *nipponica* MINATO, "*Lonsdaleia*" *katoi* OZAWA, *Taisyakuphyllum rostfer* MINATO, *Amygdalophylloides gracilis* (HAYASAKA), *A. gerthi* (OZAWA), *Lithostrotionella* spp., "*Khmerophyllum*" sp.

Limestone of the *Profusulinella* zone.....70 m

Contained fossils are as follows: *Profusulinella beppensis* TORIYAMA, *P. rhomboides* (LEE et CHEN), *P.* sp. A nov., *P.* sp. B nov., *P.* sp., *Akiyoshiella ozawai* TORIYAMA, *A.* sp., *Eoschubertella* sp., *Staffella* sp., *Ozawainella* sp., *Millerella?* sp., *Chaetetiporella* sp.

Limestone of the *Millerella* zone.....430 m
Contained fossils are as follows: *Millerella* spp., *Paramillerella* spp., *Ozawainella* sp., *Lonsdaleoides toriyamai* MINATO, "*Clisaxophyllum*" *atetsuense* MINATO et NAKAZAWA, "*Stylidophyllum*" sp. A. "S." sp. B, *Echigophyllum* sp., *Pseudopavona* spp., *Axolithophyllum* sp., "*Corwenia*" *omiensis* (YABE et HAYASAKA), *Chaetetiporella* sp.
Limestone of the *Nagatophyllum* zone, with intercalation of thin, irregular patches of greenish, purplish, basaltic tuffs in the lower part .....200 m
Contained fossils are as follows: *Nagatophyllum satoi* OZAWA, "*Meniscophyllum*" *longiseptatum* MINATO, "*Polycoelia*" *japonica* OZAWA, *Amplexocarinia?* sp., "*Caninia*" sp., *Heterophyllia??* sp., *Akiyosiphyllum stylophorum* YABE et SUGIYAMA, *Cionodendron pseudocolumen* KATO (MS), *Pseudoromingeria kotoi* (YABE et HAYASAKA), *Amygdalophyllum naosoideum* MINATO, *Lonsdaleoides enormis* (OZAWA), *L. toriyamai* MINATO, "*Clisaxophyllum*" *densicolumellatum* KATO (MS), "*C.*" *atetsuense* MINATO et NAKAZAWA.
Greenish, purplish basaltic tuffs.....70 m(+)
Reddish tuffaceous shale .....150 m

Thus, waagenophyllid corals seem to be distributed in the Akiyoshi province in several zones or subzones, viz. in the *Triticites simplex* subzone, *Pseudofusulina kraffti magna* subzone, *Neoschwagerina craticulifera* subzone, *Gifuella douvillei* subzone, and *Yabeina-Lepidolina* zone.

Of the zones and subzones, established by HASEGAWA in the Akiyoshi province, the *Yabeina-Lepidolina* zone doubtlessly corresponds to the *Yabeina globosa* zone in the Akasaka province, and the so-called *Gifuella douvillei* subzone in both provinces is perfectly synchronous with each other. Further, where *Gifuella gifuensis* HONJO and *Neoschwagerina colaniae* OZAWA are only found in the *Neoschwagerina haydeni* subzone in the Akiyoshi province, the same two species are characteristic in the *Yabeina ozawai* subzone in the Akasaka province. The *Neoschwagerina haydeni* subzone, about 7 m in thickness plus the *Verbeekina verbeeki* subzone some 35 m in thickness may be accordingly correlatable to the *Yabeina ozawai* subzone in the Akasaka province in rough estimation, which is, according to HONJO, some 90 m in thickness.

Both *Neoschwagerina craticulifera* and *Neoschwagerina irregularis* are representative species in the *Neoschwagerina craticulifera* subzone in the Akasaka province, while the former species ranges in the Akiyoshi province from the same named *Neoschwagerina craticulifera* subzone to the *Verbeekina heimi* subzone, although the latter is only found in the *Neoschwagerina craticulifera* subzone of

Akiyoshi. In all probability, the *Neoschwagerina craticulifera* subzone plus the *Pseudodoliolina ozawai* subzone in the Akasaka province may be accordingly correlatable to the so-called *Neoschwagerina craticulifera* subzone plus the *Verbeekina heimi* subzone in the Akiyoshi province, through a comparison of the geological distribution of more important fusulinid foraminifera.

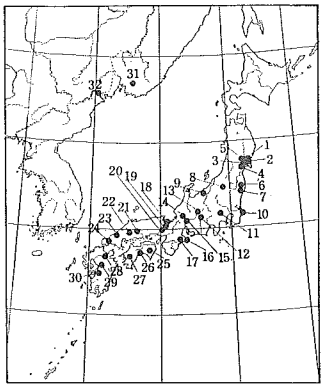
The presence of *Neoschwagerina simplex* in the *Neoschwagerina craticulifera* subzone in the Akiyoshi province is worthy of note, which is one of the characteristic forms in the *Minoella nipponica* subzone in the Akasaka province. Perhaps, the upper half of the *Parafusulina* zone in the Akiyoshi province can be accordingly viewed to be nearly equivalent to the *Minollea nipponica* subzone in the Akasaka province, although no other coexisting fusulinids are found in either of them.

Then, how can Permian formation of the Akiyoshi and Akasaka provinces be correlated to that of the Kitakami mountains? In the Kitakami district, neoschwagerinids are in general extremely rare, so that the *Neoschwagerina* zone there can be hardly compared with that of any other district in detail. As it was stated in the foregoing pages, however, the *Lepidolina* zone in the Kitakami mountains may be roughly correlatable to the *Yabeina globosa* zone or *Yabeina-Lepidolina* zone in Akiyoshi. Further, the *Gifuella douvillei* zone designated in the Kitakami district can be viewed to be perfectly synchronous with the same named subzone in both Akasaka and Akiyoshi provinces.

Meanwhile, there is a horizon which is quite characteristic in its abundant presence of *Pseudofusulina vulgaris* and its varieties in the lower Permian sequence of the Akiyoshi province, and this may be roughly correlatable to the middle part of the limestones of the Sakamotosawa series in the Kitakami mountains. That is to say, the *Pseudofusulina vulgaris* subzone in Akiyoshi may stratigraphically be almost equivalent with the so-called J_0 horizon of the Sakamotosawa series, which is also characterized by the presence of *Pseudofusulina vulgaris* var. *globosa*. If this be true, the top of the upper Sakamotosawa series (so-called J_1 horizon) in which *Michelinia* (*Michelinopora*) *multitabulata*, *Yatsengia kabayamaensis*, *Pseudofusulina* and *Parafusulina* are found, can be viewed to be almost synchronous with the *Pseudofusulina kraffti magna* subzone in the Akiyoshi province. In fact, *Pseudofusulina kraffti* is not seldom found at the top of the Sakamotosawa limestone in the Kitakami mountains. Therefore, the *Monodiexodina* zone, the lower Kanokura series of the Kitakami mountains seems to be correlatable to the *Minoella* zone at Akasaka or the uppermost part of the *Parafusulina* zone in the Akiyoshi province, although neither coexisting genera nor species among fossils of both formations have been found to date. Yet, the presence of unconformity at the base of the Kanokura series must be noteworthy, because an unconformable relation between the *Parafusulina* zone and underlying formation was newly ascertained by HASEGAWA also in the Akiyoshi province.

Finally, the *Pseudoschwagerina* zone in the Akiyoshi province seems to be

stratigraphically almost equivalent with the lower Sakamotosawa series. In the *Tirticites simplex* subzone in Akiyoshi, *Pseudoschwagerina* is also present, although not dominant. Therefore, the *Pseudoschwagerina* zone of the Akiyoshi province can be viewed to be stratigraphically equivalent with the Sakamotosawa series in rough estimation, at least the horizons ranging from I_0 until I_1 in Kitakami may correspond to the *Pseudoschwagerina muongthensis* subzone of Akiyoshi. The major divisions of the Permian in three typical districts in Japan are thus established based mainly on the fusulinid foraminiferas as stated above, although there are at present many problems unsolved regarding possible detailed subdivisions and their correlations.



Text-figure 10:

Map showing the distribution of waagenophyllid corals in the Japanese islands and their neighbourhood.

1. Setamai district, Iwate Pref.
2. Kesennuma district, Miyagi Pref.
3. Nagasaka district, Iwate Pref.
4. Maiya district, Miyagi Pref.
5. Mayu in Iwate Pref.
6. Soma in Fukushima Pref.
7. Mt. Takakurayama, Fukushima Pref.
8. Mizutani mine, Niigata Pref.
9. Omi limestone, Niigata Pref.
10. Chohsi, Chiba Pref.
11. Buko-zan etc. in Kwanto mountains.
12. Shiojiri, Nagano Pref.
13. Fukuji, Gifu Pref.
14. Imogadaira, Fukui Pref.
15. Akasaka limestone, Gifu Pref.
16. Shima district, Mie Pref.
17. Fujiwara-dake mountain, Mie Pref.
18. Nabae, Kyoto Pref.
19. Oharano, Kyoto city.
20. Takatsuki city, Osaka Pref.
21. Atetsu plateau, Okayama Pref.
22. Taisyaku district, Hiroshima Pref.
23. Kane district, Yamaguchi Pref.
24. Akiyoshi limestone, Yamaguchi Pref.
25. Hisone, Tokushima Pref.
26. Sakawa and its adjacent areas, Kochi Pref.
27. Nomura-cho, Ehime Pref.
28. Mikuni Pass, Oita Pref.
29. Mizukoshi, Kumamoto Pref.
30. Kasamatsu, Yatsushiro, Kumamoto Pref.
31. Suchan district, Coastal region, U.S.S.R.
32. Toman district, Northeast China

Of course, many other waagenophyllid corals in Japan other than those listed

in the foregoing pages are known. The recording of all known species with regard to stratigraphy would be time and space consuming. Thus we wish only to list such corals as given below in regard their geographical distribution and roughly estimated stratigraphical horizons in comparison to the standard divisions of the Japanese Permian.

The following is a schematic of the stratigraphical divisions, which will be applied to show the stratigraphical range of the Japanese waagenophyllids:

Non-fusulinid bearing zone
Yabeina-Lepidolina zone
Neoschwagerina zone { *Gifuella douvillei* subzone / *Neoschwagerina craticulifera* subzone }
Parafusulina-Monodiexodina zone
Pseudofusulina zone { *Pseudofusulina kraffti* subzone / *Pseudofusulina vulgaris* subzone }
Pseudoschwagerina zone

4) RECORDS ON THE OCCURRENCE OF WAAGENOPHYLLIDS IN JAPAN

There are many records on the stratigraphical occurrence of waagenophyllid corals from the Japanese Permian. And they will be found in numerous scattered literatures.

Readers are cordially asked to refer them in the bibliography appeared in MINATO's paper (1955) in which many stratigraphic papers on Japanese Upper Palaeozoics are listed.

Here we are going to summarize these records in tabular form. (See text-fig. 10 showing localities for corals).

Species marked with asterisks are forms of either we have examined through published figures or in studying actual thin sections of them.

TOHOKU REGION

Locality: 500 m. W. of Mayu hot spring, Genbi, W. of Ichinoseki, Iwate Prefecture. *Yabeina* zone?

Waagenophyllum cfr. *indicum* (W. et W.)—KITAMURA & TANI (1953).

Yamamoto, Yonesato, Esashi city, Iwate Prefecture. Tochu formation = *Pseudoschwagerina* zone

**Wentzelella* sp.—MINATO (1955)

Kami-o-uchizawa, Yonesato, Esashi city, Iwate Prefecture. Tochu formation = *Pseudoschwagerina* zone

Wentzelella timorica (GERTH)—ONUKI (1956)

River bank of Sarusawa, E. of Higashi-iwaisato, Higashiyama-cho, Higashi-iwai-gun,

Iwate Prefecture. Kanokura series.—NODA (1934), ONUKI (1956)
Waagenophyllum indicum (W. et W.)
Waagenophyllum sp.

E. of Nagadaira, W. of Zizodo, N.E. of Maruki, W. of Takakura, all in Higashiyama-cho, Higashiiwai-gun, Iwate Prefecture. Kanokura series.
Wentzelella sp.—NODA (1934), ONUKI (1956)

S. of Fukabori, W. of Matsukawa railway station, Abu pass, W. of Sunajiya and Oniki, in Kawasaki-cho, Higashiiwai-gun, Iwate Pref. Kanokura series.
Wentzelella sp.—NODA (1934) & ONUKI (1956)

Sanmaiyashiki, Maikawa, Ichinoseki city, Iwate Prefecture. Kanokura series—*Yabeina* zone
**Waagenophyllum* (*Waagenophyllum*) *indicum* (WAAGEN et WENTZEL)

E. of Namiki, Mataki village, Higashiiwai-gun, Iwate Pref. Kanokura series
Waagenophyllum indicum (W. et W.)—ONUKI (1956)

Kattizawa, Sumita-cho, Kesen-gun, Iwate Prefecture. Kanokura series—*Neoschwagerina* zone—(see chapter on stratigraphy)
**Waagenophyllum* (*Waagenophyllum*) *indicum* (WAAGEN et WENTZEL)
**Wentzelella* (*Szechuanophyllum*) *kitakamiensis* YABE et MINATO.

Sekiya, Hikoroichi, Ofunato city, Iwate Prefectur. Sakamotosawa series—*Pseudofusulina* zone.
**Wentzelophyllum hayasakai* MINATO et KATO

Iwahata sawa, Yukisawa, Rikuzentakada city, Iwate Prefecture. Sakamosawa series—*Pseudoschwagerina* zone
**Iranophyllum* (*Laophyllum*) *nakamurai* MINATO et KATO

Miyagasa, Rotai, Towa cho, Tome-gun, Miyagi Prefecture. Rotai formation—*Pseudofusulina* zone
Wentzelella kitakamiensis YABE et MINATO—ONUKI, MURATA, BANDO & MITO (1960)

Yamazaki, Maiya, Towa cho, Tome gun, Miyagi Prefecture. Yamazaki conglomerate—*Yabeina* zone
**Waagenophyllum* (*Waagenophyllum*) *virgalense* (WAAGEN et WENTZEL)
**Wentzelloides maiyaensis* YABE et MINATO

Sashizawa, Maiya, Towa cho, Tome gun, Miyagi Prefecture. "Sakamotosawa" series—*Pseudofusulina* zone
**Pavastehphyllum* (*Sakamotosawanella*) *sakamotosawanum* MINATO et KATO

Iwaizaki, Hashikami, Kesennuma city, Miyagi Prefecture. *Neoschwagerina* zone (see chapter on stratigraphy)
**Iranophyllum* (*Iranophyllum*) *tunicatum* IGO
**Waagenophyllum* (*Waagenophyllum*) *virgalense* (WAAGEN et WENTZEL)
**Parawentzelella* (*Parawentzelella*) *iwaizakiensis* (YABE et MINATO)
**Parawentzelella* (*Miyagiella*) *miyagiensis* MINATO et KATO
**Parawentzelella* (*Miyagiella*) *motoyoshiensis* MINATO et KATO
**Parawentzelella* (*Parawentzelella*) *regularis* FONTAINE

Tsukitate, Niitsuki, Kesennuma city, Miyagi Prefecture. Kanokura series—*Neo-*

schwagerina zone

**Waagenophyllum (Waagenophyllum) polyseptatum* MINATO (1955)

W. of Hisahara, Soma gun, Fukushima Prefecture. Oashi formation—*Yabeina* zone

**Waagenophyllum indicum* (W. et W.)——MINATO (1955)

**Wentzelloides maiyaensis* YABE et MINATO—SATO (1956)

E. of Takakurayama, N.E. of Yotsukura, Fukushima Prefecture. *Yabeina* zone

Wentzelella minor EGUCHI (nom. nud.)—YANAGISAWA (1957)

Mizutani mine, along the Agano river, on the border between Niigata and Fukushima Prefecture. Horizon?

Waagenophyllum cfr. *indicum* (WAAGEN et WENTZEL)—YOKOYAMA et al (1957)

KWANTO REGION

Takagami quarry, Chohshi, Chiba Prefecture. Takagami conglomerate—*Yabeina* zone

**Waagenophyllum (Waagenophyllum) pulchrum* HAMADA—MAEDA and HAMADA (1962)

Okurayama limestone, Iwato, Kanra-gun, Gunma Prefecture. *Yabeina* zone

Waagenophyllum indicum (W. et W.)—FUJIMOTO et al (1957)

Showa-Denko quarry, Buko-zan limestone, Chichibu city, Saitama Prefecture. *Pseudofusulina* zone

" *Waagenophyllum* " *yokoyamai* OZAWA—FUJIMOTO et al. (1957)

Katsubu-san, Nishi-tama-gun, Tokyo-to. *Yabeina* zone

Waagenophyllum? sp.——SAKAGAMI (1954)

CHUBU (CENTRAL) REGION

Dai-seru-quarry, Omi-cho, Nishikubiki-gun, Niigata Prefecture. *Neoschwagerina* zone

Waagenophyllum sp.——FUJITA (1958)

Summit of Mt. Kurohime, Omi-cho, Nishikubiki-gun, Niigata Pref. *Pseudofusulina* zone

**Yokoyamaella (Yokoyamaella) kurohime* MINATO et KATO

Imogadaira, Takura, Nanjo-gun, Fukui Prefecture. *Neoschwagerina* zone

**Waagenophyllum* sp.——KONISHI (1951)

Akasaka limestone, Fuwa gun, Gifu Prefecture. *Yabeina* zone

**Waagenophyllum (Waagenophyllum) akasakense* (YABE)

Waagenophyllum indicum (W. et W.)

**Waagenophyllum (Waagenophyllum) polyseptatum* MINATO

Waagenophyllum spp.

**Waagenophyllum (Waagenophyllum) compactum* MINATO et KATO

Waagenophyllum wengchengense HUANG

**Waagenophyllum (Waagenphyllum) pulchrum* HAMADA

Neoschwagerina zone

**Waagenophyllum (Waagenophyllum) polyseptatum* MINATO

**Praewentzelella honjoi* MINATO et KATO

(see chapter on stratigraphy, MINATO, 1955 & MORIKAWA et al., 1956)

Osobudani, Fukuji, Kami-takara village, Yoshiki-gun, Gifu Prefecture. *Pseudofusuline* zone

**Iranophyllum (Iranophyllum) tunicatum* IGO

**Wentzelella (Wentzelella) osobudaniensis* IGO

**Lonsdaleiastraea*? sp.——IGO (1959)

Utouyama, Shiojiri city, Nagano Prefecture. *Yabeina* zone?

**Waagenophyllum (Waagenophyllum) indicum* (WAAGEN et WENTZEL)——MINATO in KAMEI et al. (1962)

Nabae, Takahama city, Fukui Prefecture. Pebble in conglomerate of the Maizuru group *Pseudofusulina* zone?

**Wentzelella (Wentzelella) osobudaniensis* IGO

KINKI REGION

Fujiwara-dake, Inabe gun, Mie Prefecture. *Pseudofusulina* zone

Waagenophyllum sp.——MURATA (1960)

Amano-iwato, Ise city, Mie Prefecture. Osaka formation = *Parafusulina* zone?

Waagenophyllum cfr. *akasakense* (YABE)——YAMAGIWA (1953)

Osaka-pass, Isobe-cho, Shima-gun, Mie Prefecture. *Pseudofusulina* zone

Waagenophyllum sp.——YAMAGIWA (1957)

Kakinoki-dani, Towa city, Mie Prefecture. Shiraki formation = *Neoschwagerina* zone

Waagenophyllum sp.——YAMAGIWA (1953)

Shimochika, Maizuru city, Kyoto Prefecture. Pebble in conglomerate of the Permian Maizuru group.

**Wentzelella* sp.

Sogano and 750 m. E. of Onijo, Izuruhai, Oharano, Kyoto city. *Yabeina* zone

**Waagenophyllum (Waagenophyllum) virgalense* (WAAGEN et WENTZEL)——MINATO (1955), MATSUSHITA (1953)

Kannontoge limestone, Sonobe-cho, Funai-gun, Kyoto Pref. *Pseudoschwagerina* zone

**Wentzelophyllum kinkiense* (SAKAGUCHI et YAMAGIWA), 1963

A quarry east of Ogonjo, Oharano, Ukyo-ku, Kyoto city.

**Waagenophyllum (Waagenophyllum) yunnanense* CHI

Izuruha-shimojo, Takatsuki city, Osaka Prefecture. *Yabeina* zone

**Waagenophyllum (Waagenophyllum) virgalense* (WAAGEN et WENTZEL)? SAKAGUCHI & YAMAGIWA (1958)

Miharaiyama, Yabu-gun, Hyogo Prefecture. Minamitani group = *Yabeina* zone

**Wentzelella*? sp.

Mantani, Higashikumon, Ichinomiya-machi, Shiso-gun, Hyogo Pref. Upper Permian

**Waagenophyllum* sp.

CHUGOKU REGION

North of Mitsudo, Toyonaga, Niimi city, Okayama Prefecture. *Yabeina* zone

**Yokoyamaella (Maoriphyllum) nishinene* (YAMAGIWA) (1962)

**Waagenophyllum* sp.

North of Matsunagi, Toyonaga, Niimi city, Okayama Prefecture. *Neoschwagerina* zone

**Yokoyamaella (Maoriphyllum) matsushitae* (YAMAGIWA) (1962)

**Waagenophyllum* sp.

South of Yukawa, Toyonaga, Niimi city, Okayama Prefecture. *Neoschwagerina* zone

**Akagophyllum nogamie* YAMAGIWA (1962)

Matsunagi, Toyonaga, Niimi city, Okayama Prefecture. *Pseudofusulina* zone

**Akagophyllum akagoense* (OZAWA)

South of Yukawa, Toyonaga, Niimi city, Okayama Prefecture. *Pseudofusulina* zone

**Yokoyamaella (Yokoyamaella) yokoyamai* (OZAWA)

**Yokoyamaella (Yokoyamaella) tertioseptata* (YOKOYAMA)

**Waagenophyllum (Waagenophyllum) novaezelandiae* LEED

South of Matunagi, Toyonaga, Niimi city, Okayama Prefecture.—*Pseudofusulina* zone

**Yokoyamaella (Yokoyamaella) yokoyamai* (OZAWA)

South of Makiba, Toyonaga, Niimi city, Okayama Prefecture. *Pseudofusulina* zone

**Yokoyamaella* sp.——YAMAGIWA (1962)

Near the border line between Shiya and Karita village, Takada gun, Hiroshima Prefecture.

Waagenophyllum sp——IMAMURA and MATSUDA (1954).

Zenbutsuji-dani, Tojo-cho, Hiba-gun, Hiroshima Prefecture. *Yabeina* zone

**Waagenophyllum (Waagenophyllum) pulchrum* HAMADA

**Waagenophyllum (Waagenophyllum) compactum* MINATO et KATO——YOKOYAMA (1960)

Misaka, Tojo-cho, Hiba-gun, Hiroshima Prefecture. *Pseudoschwagerina* to *Pseudofusulina* zone

**Yokoyamaella (Yokoyamaella) tertioseptata* (YOKOYAMA)

**Wentzelophyllum eguchii* (YOKOYAMA), 1960

Abu quarry, Kane, Ato-cho, Yamaguchi Prefecture. *Yabeina*? zone

**Waagenophyllum (Huayunophyllum) kanense* (KAWANO), 1959

Kaerimizu, Mito-cho, Mine-gun, Yamaguchi Prefecture. *Pseudofusulina* zone

**Yokoyamaella (Yokoyamaella) yokoyamai* (OZAWA)

**Akagophyllum akagoense* (OZAWA)

**Akagophyllum yabei* MINATO et KATO

Serida, Shuho-cho, Mine-gun, Yamaguchi Prefecture. *Neoschwagerina* or *Yabeina* zone

**Ipciphyllum laosense* (PATTE)

Shiraiwa, Mine city, Yamaguchi Prefecture. *Yabeina* zone

**Waagenophyllum (Waagenophyllum) pulchrum* HAMADA

**Yokoyamaella (Maoriphyllum) minense* MINATO et KATO

Parafusulina zone?

**Ipciphyllum laosense* (PATTE)

Shibukura, Mine city, Yamaguchi Prefecture. *Neoschwagerina* zone

**Yokoyamaella (Maoriphyllum) ozawai* (MINATO)

Shigeyasu, Mine city, Yamaguchi Prefecture. *Yabeina*? or *Parafusulina*? zone

Ipciphyllum laosense (PATTE)

Hinaga, Mine city, Yamaguchi Prefecture. *Pseudofusulina*? zone or *Yabeina*? zone

Akagophyllum hasegawai MINATO et KATO

SHIKOKU REGION

Fukase, Kamodani-mura, Naka-gun, Tokushima Pref. *Yabeina* zone?

" *Lonsdaleia* " sp.——MATSUZAWA (1931)

Hisone, Kaminaka-Cho, Tokushima Prefecture. *Yabeina* zone

Waagenophyllum sp.——SUYARI (1961)

Taho and Uonashi, Nomura-cho, Higashi-Uwa-gun, Ehime Prefecture. Horizon?

" *Lonsdaleia* " sp.——IKEBE (1936)

Miyanari, Nomura-cho, Higashi-Uwa-gun, Ehime Prefecture. Horizon?

" *Lonsdaleia* " sp.

Nisashi, Nomura-cho, Higashi-Uwa-gun, Ehime Prefecture. Horizon?

Wentzelella cfr. *timorica* GERTH

Katakawa, Nomura-cho, Higashi-Uwa-gun, Ehime Prefecture. Horizon?

" *Lonsdaleia* " cfr. *katoi* OZAWA

Koike, near Sakawa machi, Takaoka-gun, Kochi Prefecture. *Yabeina* zone??

*" *Polythecalis* " *japonica* YABE et MINATO (1945)

Kurose, Kamaida, Yokohata and Asao, all in Kuroiwa, Sakawa-machi, Takaoka-gun, Kochi Prefecture. Horizon?

" *Lonsdaleia* " sp.——KOBAYASHI (1951)

Mimikiri and Shimoyama, Sakawa machi, Takaoka-gun, Kochi Pref. Horizon = *Yabeina* zone

**Waagenophyllum* (*Waagenophyllum*) sp. MINATO (1955)

North of Shimoyama, Sakawa, Takaoka-gun, Kochi Prefecture. *Yabeina* zone——YAMASHITA (1958)

Waagenophyllum indicum (WAAGEN et WENTZEL)

Yamanba, Sakawa machi, Takaoka-gun, Kochi Prefecture. *Parafusulina* to *Neoschwagerina* zone

**Lonsdaleiastraea yamanbaensis* MINATO (1949)

Kurotaki, Sakawa machi, Takaoka-gun, Kochi Prefecture. Horizon?

Waagenophyllum indicum (WAAGEN et WENTZEL)

South of Yachi, Kitahara, Tosa city, Kochi Prefecture. Horizon?

" *Lonsdaleia* " sp.——KOBAYASHI (1931)

Yasuba, Shinkai-mura, Nagaoka-gun, Kochi Prefecture. *Yabeina* zone——KOBAYASHI (1951)

Waagenophyllum indicum (WAAGEN et WENTZEL)

Sakuradani, Kaminaga cho, Naka-gun, Tokushima Prefecture. Horizon?——KOBAYASHI (1951)

Wentzelella cfr. *kitakamiensis* YABE et MINATO

KYUSHU REGION

North of Katauchi, near Mikuni pass, Ohita Prefecture. *Pseudofusulina* zone

Waagenophyllum akagoensis (OZAWA)——NODA (1961)

Mizukoshi, Mifune-machi, Kami-machiki-gun, Kumamoto Pref. *Yabeina* zone

Waagenophyllum sp.——YANAGIDA (1958)

" *Lonsdaleia* " sp.——FUJIMOTO (1939)

West of Toriyama, Shimodake, Toyo-mura, Yatsushiro-gun, Kumamoto Prefecture. Horizon?

" *Lonsdaleia* " sp.——OHTANI (1926)

Kasamatsu, Kawamata, Toyo-mura, Yatsushiro-gun, Kumamoto Pref. *Yabeina* zone

Waagenophyllum indicum (WAAGEN et WENTZEL)

Wentzelella sp.——KANMERA (1953)

**Waagenophyllum* (*Waagenophyllum*) *virgalense* (WAAGEN et WENTZEL).

5) NOTES ON PALAEOECOLOGY OF WAAGENOPHYLLID CORALS

Waagenophyllid corals are commonly found in limestone facies but are less common in other types of rock facies.

Although this is an exceptional case in Japan, only one case of the external mould of *Wentzelella* from sandy slate of the Lower Sakamotosawa series in North East Honshu is known.

Most forms of waagenophyllids in this country have been found in limestone of various kinds. These limestones are sometimes black, shaly and sometimes gray, massive. Many samples of waagenophyllids are found in calcarenite. And it is rather interesting that there seems no marked difference between litho-facies in which solitary and colonial forms occur.

True coral reefs are not known in the Japanese Permian. In literature, records of occurrence of waagenophyllids are by no means uncommon. But the actual findings of corals in strata are not too common.

Rocks packed with masses of waagenophyllids are not frequent.

At Iwaizaki, Miyagi Prefecture, the limestone of the horizon termed D by MORIKAWA et al. (1958) shows a gray, maasive nature, and yields *Yatsengia* and *Parawentzelella* in association in abundance. These corals partly show a reefy aspect. And the horizon D may be correlatable to the *Neoschwagerina* zone in the fusulinid zonation.

In the Akasaka limestone, central Japan, *Waagenophyllum akasakense* is very common in " Kuro-tai " (black zone), which is characterized by abundant *Yabeina globosa*. The lithology of this zone is black, muddy limestone bearing numerous *Mizzia*, *Yabeina* and many molluscan fossils together with white coloured bushy *Waagenophyllum*, which is however, not in a form of a real reef.

Examples of rather common occurrence of waagenophyllids, though not abundant, are cases of *Yokoyamaella* and *Akagophyllum* in the *Pseudofusulina* zone of the Akiyoshi and some other limestones of Southwest Japan. This coral bearing

part of the limestones contain few fusulinids, *Sinopora*, and show a rather massive structure, which is light gray in colour, partially muddy, and partially bioclastic. This may be called a patchy occurrence of corals.

Generally encrinite limestone and fusulinid limestone are rare in corals, as well as other organic remains.

Iranophyllum (*Laophyllum*) *nakmurai* was obtained from the *Pseudoschwagerina* band of the Sakamotosawa series of the Kitakami mountains, but it is extremely rare in occurrence.

As to the faunal association, smaller foraminifera occur together with waagenophyllids in massive, and muddy limestone, or in bioclastic limestone. Among the forms, *Pachyphloia* is rather common at Chohshi, Chiba Prefecture.

Some types of bryozoa are found growing on the corallite surface of *Waagenophyllum virgalense* at Iwaizaki, Miyagi Prefecture. Algal remains are also not uncommon, occurring together with waagenophyllids.

In only one case a rudiciform process is known in a form of *Wentzelophyllum* from Sekiya, Iwate Prefecture. The organ might have helped the coral in settling on the floor of calcareous mud. The presence of a similar process can be pointed out on the surface of epitheca of some forms of Chinese *Polythecalis*, in the form of many nodes or tubercles which are actually the bases of these rudiciform processes which have been illustrated by HUANG and others.

In Japan, waagenophyllid corals are seldom badly destructed in rocks, and only some of them show signs of transportation before they were finally buried and eventually fossilized. In this latter case, corals are externally a little coroded and occur within calcarenite.

At the end of this short note remarks on seasonal growth of waagenophyllid corals are thought to be desirable. But as far as our observation goes there seems to be no marked evidence of seasonal growth in this group of corals, although in some aphroid corals found in China a weak indication of alternation of coarse dissepiments and compratively finer ones is recognizable. (See plate 10, fig. 6b, and fig. 2a on plate 11 in HUANG, 1932).

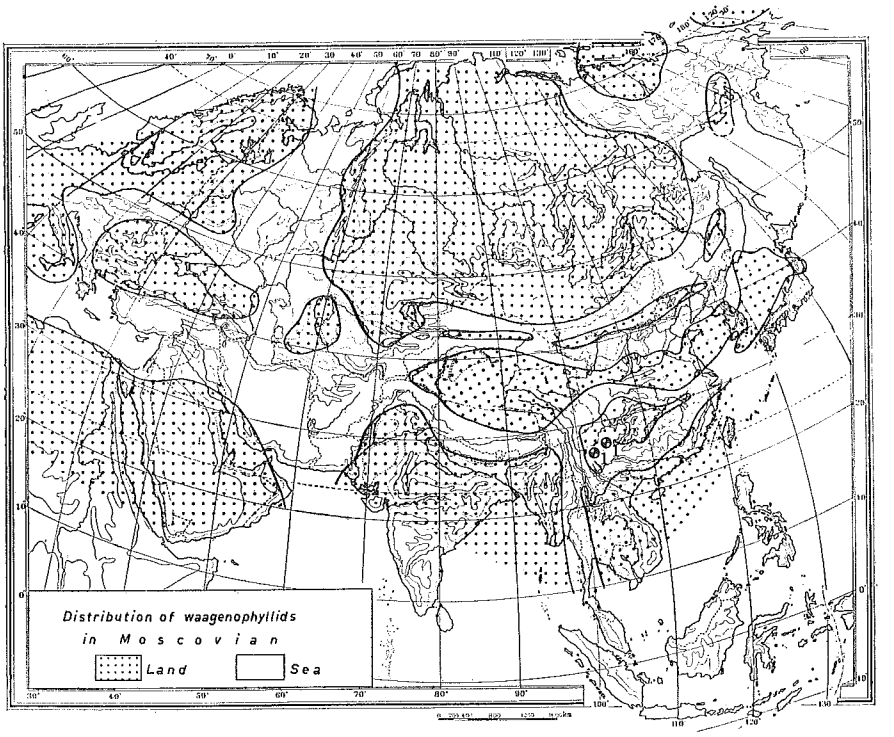
6) PALAEO-ZOOGEOGRAPHICAL PROVINCE BASED ON THE DISTRIBUTION OF WAAGENOPHYLLIDAE

It is already a fairly well known fact that " *Waagenophyllum* " and " *Wentzelella* " are widely distributed in the Tethys sea region. This fact has been more firmly established by our present study. It must be especially emphasized that no species belonging to Waagenophyllidae have ever been found from the sea region covering the Ural mountains of the present day and the vast area of the sea extending immediately north of the Japanese islands, although those seas above stated were certainly united with the Tethys sea in the Permian.

As may be seen the geographical distribution of Waagenophyllidae as shown in a series of maps newly compiled (figs. 11 to 18), almost all the genera and subgenura of this group of corals have been found only from the Tethys sea province, having existed in the south of the old " Eurasian " continent, but not in any other regions outside of that sea. A single exception of this statement is *Heritschiella girtyi* (MOORE et JEFFORDS), which is known from the Lower Permian of Kansas, U.S.A.

This coral can also be regarded to have been found within the extent of the Tethys sea. However, it must be noted that it was located outside of " Eurasia ".

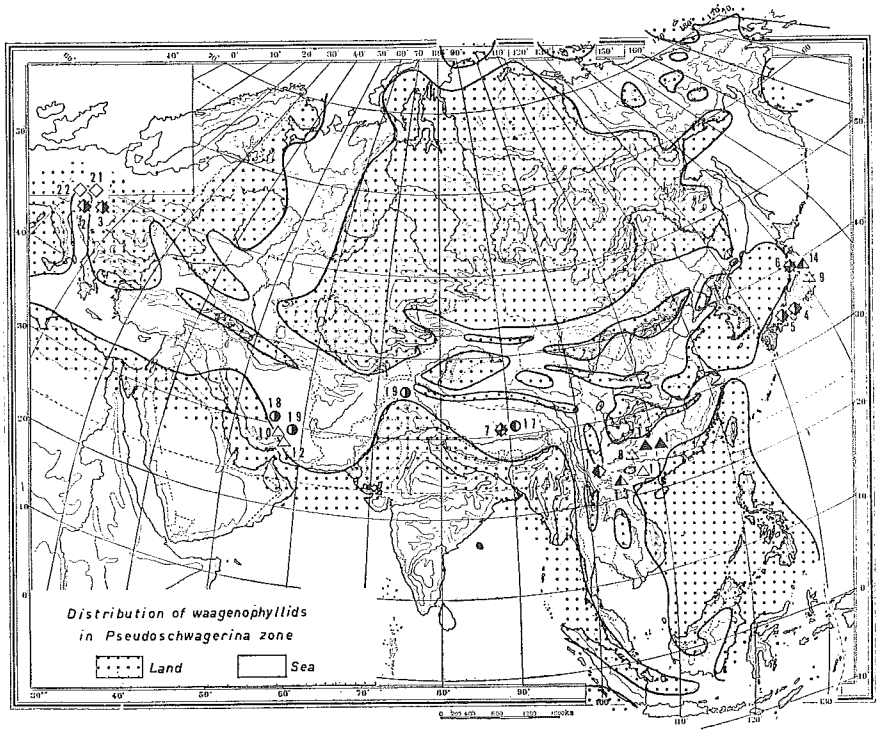
Next, the ancestral or earlier form for each genus or subgenus seems to have first appeared somewhere in the central area of the Tethys sea province. This may be also concluded from the maps showing the geological and geographical distribution of certain forms of waagenophyllid corals (fig. 19 to 25). It is rather peculiar that most of the earlier forms for each bioseries of this group of corals are



Text-figure 11

Distribution of waagenophyllids in Moscovian.

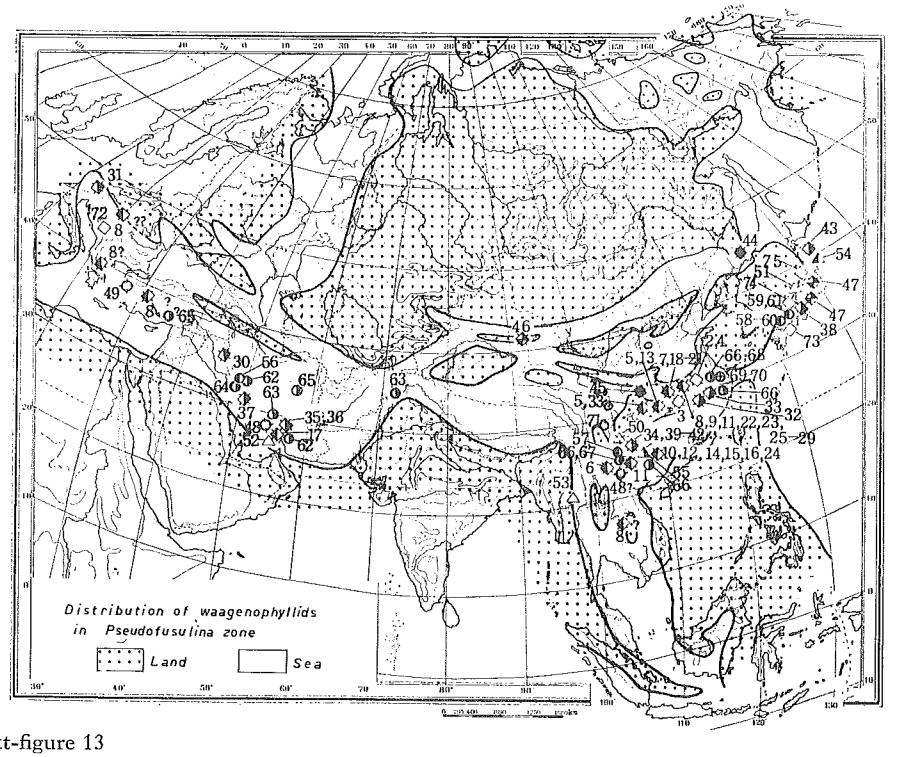
1 : *Huangia chütsingensis* (Chi).



Text-figure 12

Distribution of waagenophyllids in *Pseudoschwagerina* zone

1. *Polythecalis* sp.
2. *Wentzelophyllum felseri* MANATO et KATO
3. *W. arminiae* (FELSER)
4. *W. kinkiense* (SAKAGUCHI et YAMAGIWA)
5. *W. eguchii* (YOKOYAMA)
6. *Wentzelella* sp.
7. *Wentzelella salinaria* (WAAGEN et WENTZEL) var.
8. *Iranophyllum* (*Iranophyllum*) *amygdalophylloideum* (HUANG)
9. *Iranophyllum* (*Laophyllum*) *nakamurai* MINATO et KATO
10. *Pavastehphyllum* (*Thomasiphyllum*) *reticulatum* (DOUGLAS)
11. *P.* (*T.*) *nantanense* (YÜ)
12. *P.* (*T.*) *arachnoides* (DOUGLAS)
13. *P.* (*Sakamotosawanella*) *permicum* (CHI)
14. *P.* (*S*). *sakamotosawanum* MINATO et KATO
15. *P.* (*Pseudocarniaphyllum*) *orientale* WU
16. *P.* (*P.*) *convexum* WU
17. *Akagophyllum tibeticum* (REED)
18. *Pseudohuangia minima* (DOUGLAS)
19. *P. chitralica* (SMITH)
20. *Heritschiella girtyi* (MOORE et JEFFORDS) (not illustrated)
21. *Yokoyamaella* (*Yokoyamaella*) *carinthiaca* (HERITSCH)
22. *Y.* (*Y.*) *stillei* (HERITSCH)

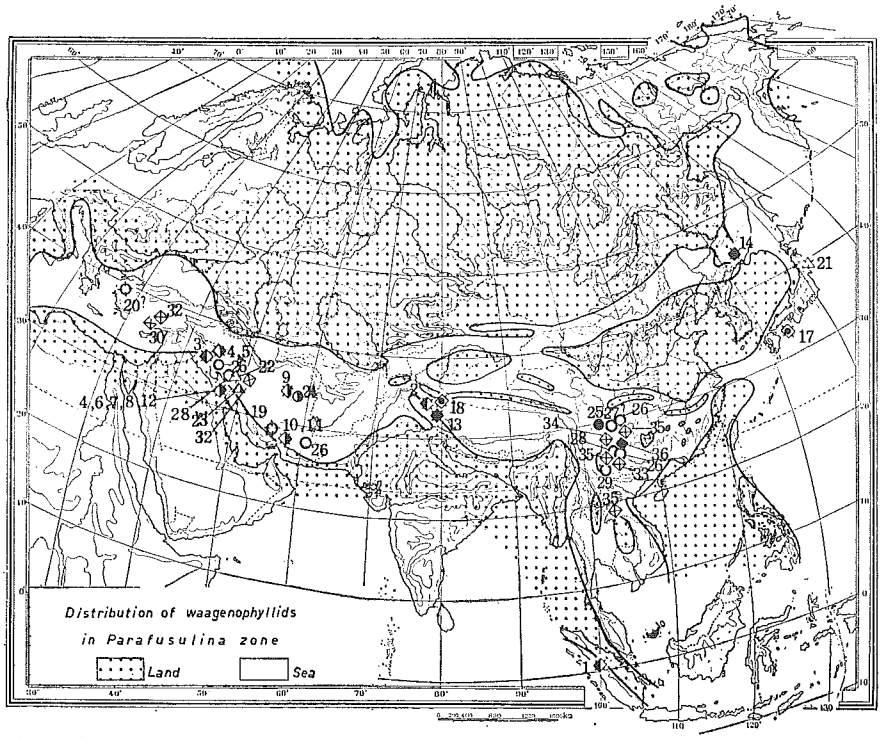


Text-figure 13

Distribution of waagenophyllids in *Pseudofusulina* zone

1. *Chusenophyllum paeonoidea* TSENG
2. *C. asteroidea* TSENG
3. *C. tungliangensis* (HUANG)
4. *C. breviseptatum* TSENG
5. *Polythecalis chinensis* (GIRTY)
6. *P. confluens* YABE et HAYASAKA
7. *P. verbeekielloides* HUANG
8. *P. rosiformis* HUANG
9. *P. multicystosis* HUANG
10. *P. yangtzeensis* HUANG
11. *P. hochowensis* HUANG
12. *P. polygonalis* HUANG
13. *P. chinmenensis* HUANG
14. *P. langpoensis* HUANG
15. *P. dupliformis* HUANG
16. *P. flatus* HUANG
17. *P. grayi* DOUGLAS
18. *P.* ? *huangi* TSENG
19. *P.* ? *wangi* TSENG
20. *P.* ? *hexagonalis* TSENG
21. *P.* ? *nankingensis* TSENG
22. *P. simplex* ZHAO et CHEN
21. *P.* ? *nankingensis* TSENG
22. *P. simplex* ZHAO et CHEN
23. *P. irregularis* ZHAO et CHEN
24. *P. denticulatus* (HUANG)
25. *P. crassiseptata* ZHAO et CHEN
26. *P. abnormis* ZHAO et CHEN
27. *P.* sp.
28. *P. minor* ZHAO et CHEN
29. *P. choxianensis* ZHAO et CHEN
30. *Wentzelophyllum* ? *gelikhanense* MINATO et KATO
31. *W. arminiae* (FELSER)
32. *W. intermedium* (HUANG)
33. *W. chaoi* (HUANG)
33. *W. huayunshanense* (TSENG)
34. *W. kueichowense* (HUANG)
35. *W. kueichowense* var. *alpha* (DOUGLAS)
36. *W. kueichowense* var. *beta* (DOUGLAS)

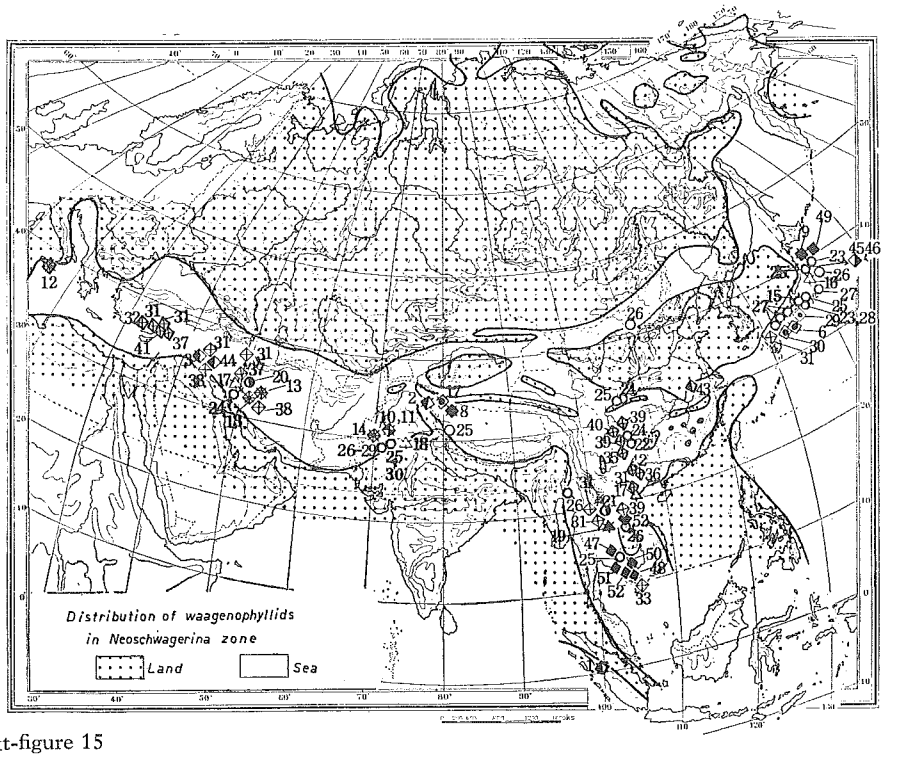
37. *W.* cfr. *kueichowense* (HUANG)
38. *W. eguchii* (YOKOYAMA)
39. *W. volzi* (YABE et HAYASAKA)
40. *W. volzi* mut. *alpha* (HUANG)
41. *W. volzi* mut. *beta* (HUANG)
42. *W. volzi* mut. *gamma* (HUANG)
43. *W. hayasakai* MINATO et KATO
44. *Wentzelella* (*Szechuanophyllum*) *szechuanensis* (HUANG) var.
45. *W.* (*S.*) *szechuanensis* (HUANG)
46. *Wentzelella* (*Wentzelella*) *simplex* YÜ et LIN
47. *W.* (*W.*) *osobudaniensis* IGO
48. *Praewentzelella magnifica* (DOUGLAS)
49. *P. multiseptata* (ENDERLE)
50. *Iranophyllum* (*Iranophyllum*) *amygdalophylloideum* (HUANG)
31. *I.* (*I.*) *tunicatum* IGO
52. *Pavastephyllum* (*Thomasiphyllum*) *arachnoides* (DOUGLAS)
53. *P.* (*T.*) *spongifolium* (SMITH)
54. *P.* (*Sakamotosawanella*) *sakamotosawanum* M. et K.
55. *P.* (*Pavastehphyllum*) *nontabulatum* (HUANG)
56. *Akagophyllum* sp.
57. *A. parachihsiaensis* (HUANG)
58. *A. hasegawai* MINATO et KATO
59. *A. akagoense* (OZAWA)
60. *A. yabei* MINATO et KATO
61. *A. nogamie* (YAMAGIWA)
62. *Pseudohuangia persica* (DOUGLAS)
63. *P. chitralica* (SMITH)
64. *P. tabellata* (DOUGLAS)
65. *P. stoecklini* MINATO et KATO
66. *P. chiuyaoshanensis* (HUANG)
67. *P. lipoensis* (HUANG)
68. *P. tsengi* (ZHAO et CHEN)
69. *Chihsiaphyllum diphyphylloideum* (HUANG)
70. *C. chihsiaense* (YOH)
71. *Waagenophyllum* (*Chaoiphyllum*) *chaoi* MINATO et KATO
72. *Yokoyamaella* (*Yokoyamaella*) *kaludjeracensis* MINATO et KATO
73. *Y.* (*Y.*) *yokoyamai* (OZAWA)
74. *Y.* (*Y.*) *tertioseptata* (YOKOYAMA)
75. *Y.* (*Y.*) *kurohime* MINATO et KATO



Text-figure 14

Distribution of waagenophyllids in *Parafusulina* zone

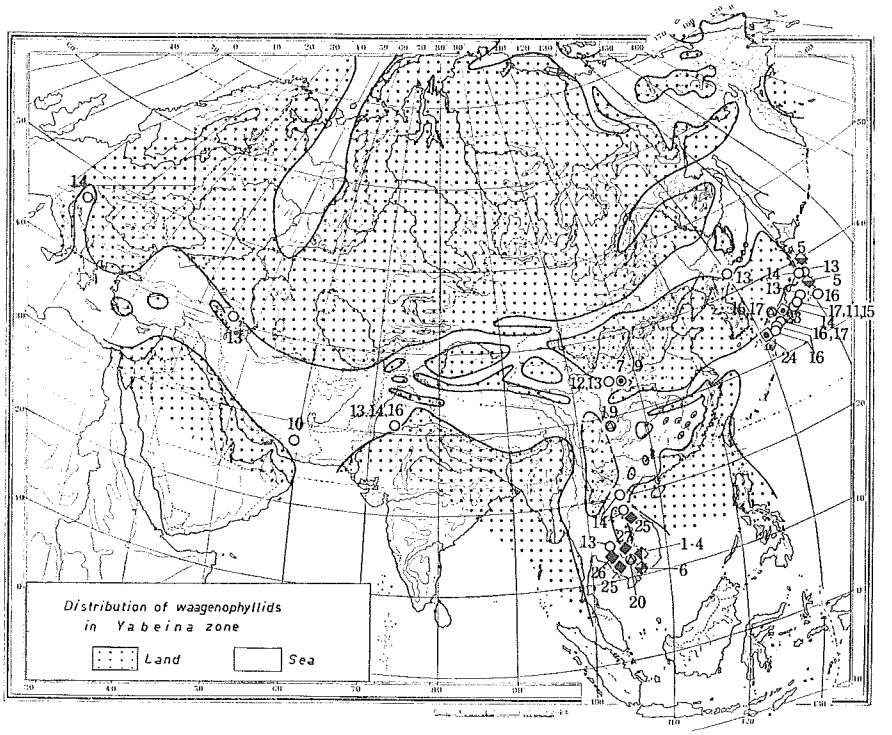
1. *Polythecalis frechi* (VOLZ)
2. *P. variabilis* (GERTH)
3. *P.* sp.
4. *Wentzelophyllum ? persicum* (DOUGLAS)
5. *W. ? gelikhanense* MINATO et KATO
6. *W. ? jenningsi* (DOUGLAS)
7. *W. ? orientale* (DOUGLAS)
8. *W. ? douglasi* MINATO et KATO
9. *W. ? tabasense* MINATO et KATO
10. *W. kueichowense* var. *alpha* (DOUGLAS)
11. *W. kueichowense* var. *beta* (DOUGLAS)
12. *W.* cfr. *kueichowense* (HUANG)
13. *Wentzelella* (*Szechuanophyllum*) *caracorumensis* GERTH
14. *W.* (*S.*) *szechuanensis* (HUANG) var.
15. *Lonsdaleiastraea vinassai* GERTH (see text-fig. 17)
16. *L. molengraaffi* (GERTH) (see text-fig. 17)
17. *L. yamanbaensis* MINATO
18. *L. typica* GERTH
19. *Praewentzella magnifica* (DOUGLAS)
20. *P. multiseptata* (ENDERLE)
21. *Iranophyllum* (*Iranophyllum*) *tunicatum* IGO
22. *I.* (*I.*) *splendens* DOUGLAS
23. *Pavastehphyllum* (*Pavastehphyllum*) *simplex* (DOUGLAS)
24. *Pseudohuangia stoecklini* MINATO et KATO
25. *Waagenophyllum* (*Chaoiphyllum*) *chaoi* MINATO et KATO
26. *W.* (*Waagenophyllum*) *kueichowense* HUANG
27. *W.* (*W.*) *longiseptatum* TSENG
28. *W.* (*W.*) *wengchengense* HUANG
29. *W.* (*W.*) *yunnanense* CHI
30. *Ipciphyllum heritschi* MINATO et KATO
31. *I. timoricum* (GERTH) (see text-fig. 17)
32. *I. persicum* (DOUGLAS)
33. *I. elegans* (HUANG)
34. *I. gnomeiense* (HUANG)
35. *I. huangi* MINATO et KATO
36. *Parawentzelella* (*Parawentzelella*) *paracanalifera* (HUANG)



Text-figure 15

Distribution of waagenophyllids in *Neoschwagerina* zone

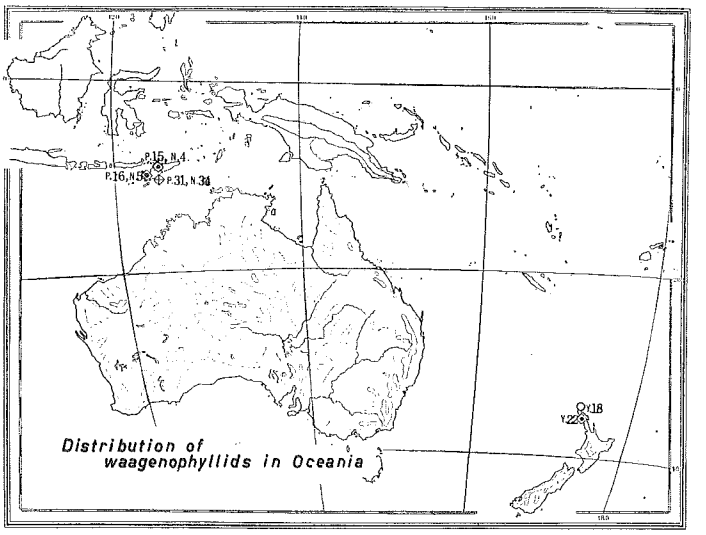
1. *Polythecalis frechi* (VOLZ)
2. *P. variabilis* (GERTH)
3. *P.* sp.
4. *Lonsdaleiastraea vinassai* GERTH (see text-fig. 17)
5. *L. molengraaffi* (GERTH) (see text-fig. 17)
6. *L. yamanbaensis* MINATO
7. *L. typica* GERTH
8. *Wentzelella* (*Szechuanophyllum*) *caracorumensis* GERTH
9. *W.* (*S.*) *kitakamiensis* YABE et MINATO
10. *Wentzelella* (*Wentzelella*) *wynnei* (WAAGEN et WENTZEL)
11. *W.* (*W.*) *salinaria* (WAAGEN et WENTZEL)
12. *Wentzelellites sicula* (GALLITELLI)
13. *W. harrisoni* (DOUGLAS)
14. *W. senni* MINATO et KATO
15. *Praewentzelella honjoi* MINATO et KATO
16. *Iranophyllum* (*Iranophyllum*) *tunicatum* IGO
17. *I.* (*I.*) *splendens* DOUGLAS
18. *I.* (*I.*) *indicum* (DE KONINCK)
19. *I.* (*Laophyllum*) *pongouaense* (MANSUY)
20. *Pseudohuangia cincta* (DOUGLAS)
21. *P. counilloni* (MANSUY)
22. *Waagenophyllum* (*Waagenophyllum*) *kueichowense* HUANG
23. *W.* (*W.*) *polyseptatum* MINATO
24. *W.* (*W.*) *wengchengense* HUANG
25. *W.* (*W.*) *indicum* (WAAGEN et WENTZEL)
26. *W.* (*W.*) *virgalense* (WAAGEN et WENTZEL)
27. *W.* (*W.*) *pulchrum* HAMADA
28. *W.* (*W.*) *smithi* MINATO et KATO
29. *Yokoyamaella* (*Maoriphyllum*) *matsushitae* (YAMAGIWA)
30. *Y.* (*M.*) *ozawai* (MINATO)
31. *Ipciphyllum laosense* (PATTE)
32. *I. heritschi* MINATO et KATO
33. *I. irregularis* FONTAINE
34. *I. timoricum* (GERTH) (see text-fig. 17)
35. *I. subtimoricum* (HUANG)
36. *Ipciphyllum kwangsiense* WU
37. *I. persicum* (DOUGLAS)
38. *I. subelegans* MINATO et KATO
39. *I. huangi* MINATO et KATO
40. *I. flexuosum* (HUANG)
41. *I. anatolicum* (FLÜGEL)
42. *I. simplex* WU
43. *Paraipciphyllum elegantum* WU
44. *P. hudsoni* MINATO et KATO
45. *Parawentzelella* (*Miyagiella*) *motoyoshiensis* MINATO et KATO
46. *P.* (*M.*) *miyagiensis* MINATO et KATO
47. *P.* (*Parawentzelella*) *regularis* FONTAINE
48. *P.* (*P.*) *gubleri* FONTAINE
49. *P.* (*P.*) *iwaizakiensis* (YABE et MINATO)
50. *P.* (*P.*) *socialis* (MANSUY)
51. *P.* (*P.*) *sisophonensis* FONTAINE
52. *P.* (*P.*) *canalifera* (MANSUY)



Text-figure 16

Distribution of waagenophyllids in *Yabeina* zone

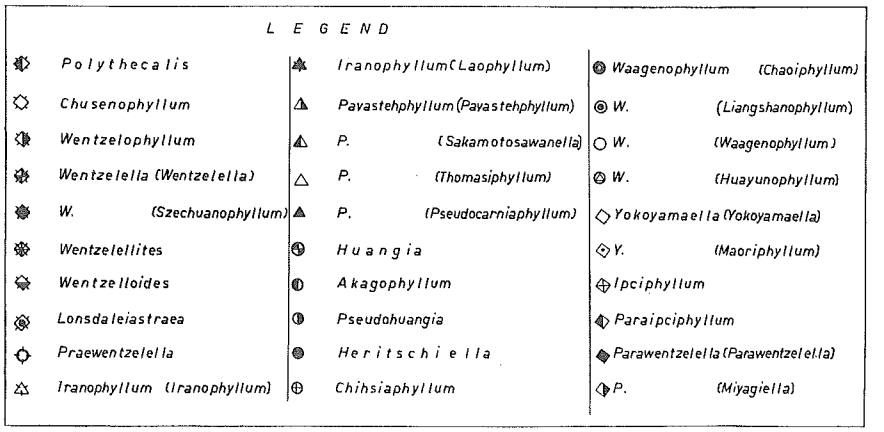
1. *Polythecalis* ? *bauryi* FONTAINE
2. *P.* ? *khmerianus* FONTAINE
3. *P.* ? *regularis* FONTAINE
4. *P.* ? *biformis* FONTAINE
5. *Wentzelloides maiyaensis* YABE et MINATO
6. *Wentzelella* (*Wentzelella*) *regularis* FONTAINE
7. *Waagenophyllum* (*Liangshanophyllum*) *lui* TSENG
8. *W.* (*L.*) *stereoseptatum* TSENG
9. *W.* (*L.*) *wui* MINATO et KATO
10. *W.* (*Waagenophyllum*) *huangi* DOUGLAS
11. *W.* (*W.*) *polyseptatum* MINATO
12. *W.* (*W.*) *simplex* WU
13. *W.* (*W.*) *indicum* (WAAGEN et WENTZEL)
14. *W.* (*W.*) *virgalense* (WAAGEN et WENTZEL)
15. *W.* (*W.*) *akasakense* (YABE)
16. *W.* (*W.*) *pulchrum* HAMADA
17. *W.* (*W.*) *compactum* MINATO et KATO
18. *W.* (*W.*) *novaezelandiae* LEED (see text-fig. 17)
19. *W.* (*Huayunophyllum*) *aequiseptatum* TSENG
20. *W.* (*H.*) *teratoideum* FONTAINE
21. *W.* (*H.*) *kanense* (KAWANO)
22. *Yokoyamaella* (*Maoriphyllum*) *maoria* (LEED) (see text-fig. 17)
23. *Y.* (*M.*) *nishinense* (YAMAGIWA)
24. *Y.* (*M.*) *minense* MINATO et KATO
25. *Parawentzelella* (*Parawentzelella*) *canalifera* (MANSUY)
26. *P.* (*P.*) *socialis* (MANSUY)
27. *P.* (*P.*) *sisophonensis* FONTAINE
28. *P.* (*P.*) *gubleri* FONTAINE



Text-figure 17

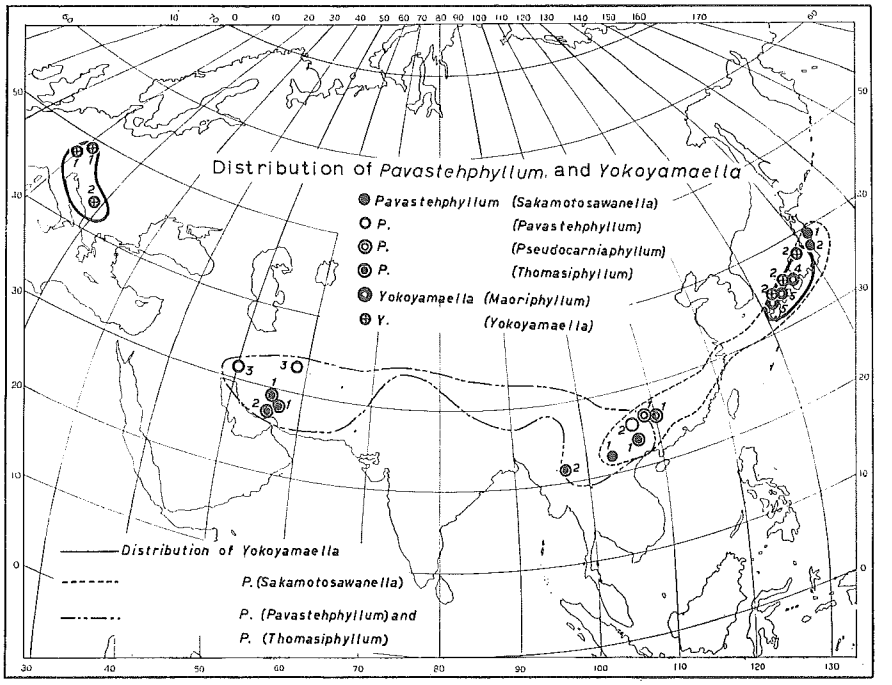
Distribution of waagenophyllids in Oceania

Parafusulina zone
P 15. *Lonsdaleiastraea vinassai* GERTH
P 16. *L. molengraaffi* (GERTH)
P 31. *Ipciphyllum timoricum* (GERTH)
Neoschwagerina zone
N 4. *Lonsdaleiastraea vinassai* GERTH
N 5. *L. molengraaffi* (GERTH)
N 34. *Ipciphyllum timoricum* (GERTH)
Yabeina zone
Y 18. *Waagenophyllum* (*Waagenophyllum*) *novaezelandiae* (LEED)
Y 22. *Yokoyamaella* (*Maoriphyllum*) *maoria* (LEED)



Text-figure 18

Legend for text-figures 11–17.



Text-figure 19

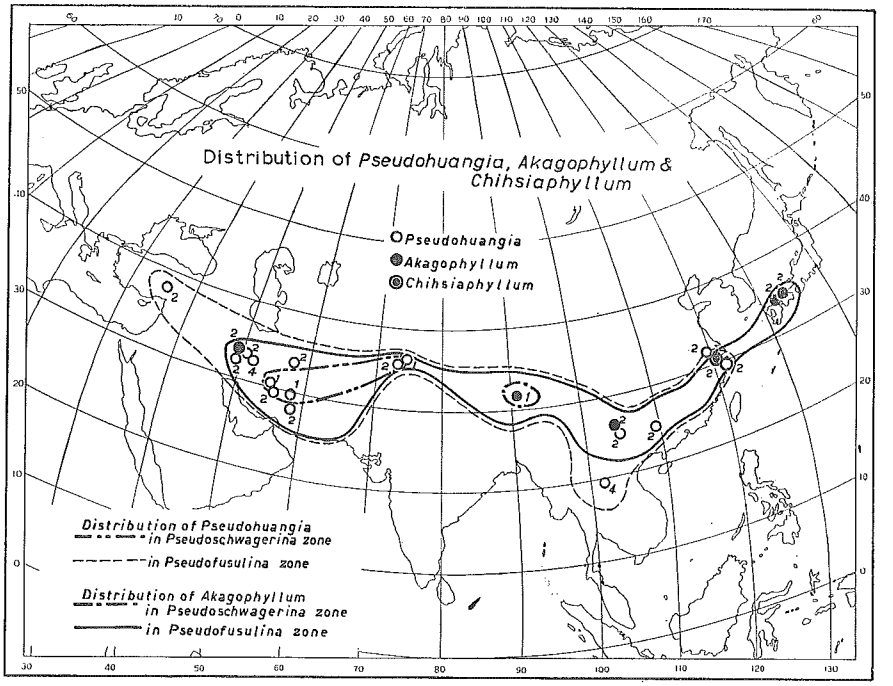
Distribution of *Pavastehphyllum* and *Yokoyamaella*. (In the following series of distribution maps numbers 1 to 5 are referring to geological ages of corals at each locality, namely 1—*Pseudoschwagerina;* 2—*Pseudofusulina;* 3—*Parafusulina;* 4—*Neoschwagerina;* and 5—*Yabeina* zones.)

only distributed in a rather limited area in the central part of the Tethys sea; namely somewhere in South China of the present day. But the matter seems apparent from the series of distribution maps mentioned above.

It is definitely not fictional. Further, the later or geologically younger forms belonging to each genus or subgenus seem to have migrated from the central area towards the east and west or to have extended further north or south in their distribution.

At present, only *Huangia* is known as the representative of the Middle Carboniferous Waagenophyllidae and we know nothing about the Upper Carboniferous waagenophyllid corals. The problem related to the distribution of this group of corals is accordingly only concerned with the Permian age. The above two facts have become quite evident and it is especially worthy of note.

Thirdly, we should like further to point out the fact, that certain specialized genera for some bioseries were found only in remote places other than the central



Text-figure 20

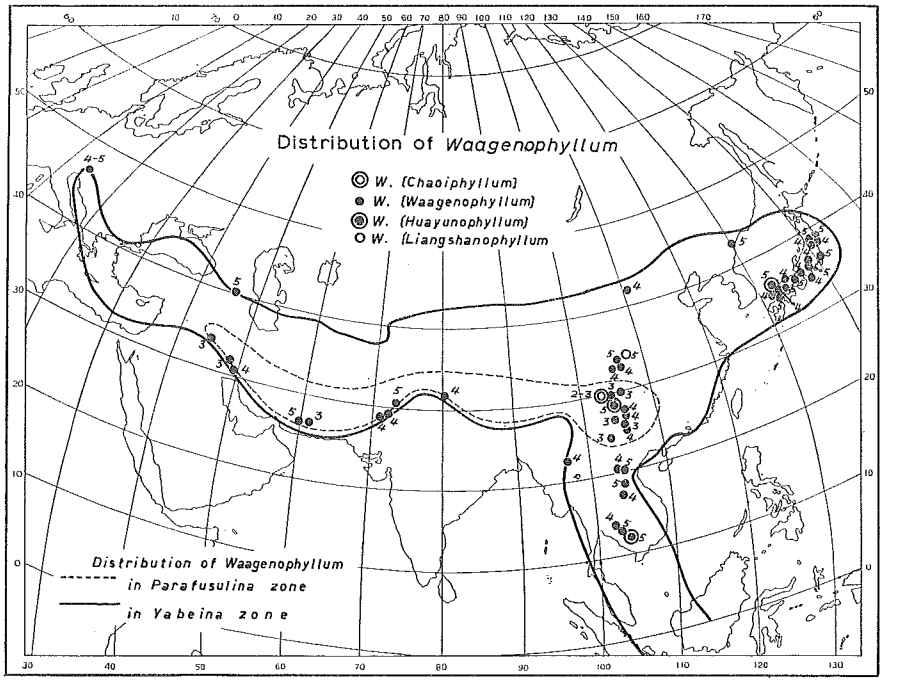
Distribution of *Pseudohuangia*, *Akagophyllum* and *Chihsiaphyllum*.

area where their ancestral or at least earlier forms are now suggested to have first appeared. *Chusenophyllum* to *Polythecalis* for instance, is one of such cases. *Maoriphyllum* to *Yokoyamaella*, *Wentzelloides* to *Wentzellela*, *Miyagiella* and *Paraipciphyllum* to *Parawentzelella* and *Huayunophyllum* to *Waagenophyllum* can be also enumerated as other examples.

However, there are also such cases in which certain genera were already far separately distributed from each other even in the early Permian. *Yokoyamaella* for instance is one of such examples. *Wentzelophyllum* can be mentioned as an another example. Both of those genera are only known in rather isolated regions at both ends (west and east) of the Tethys sea.

In this respect, we may assume that the ancestral or earlier forms of *Yokoyamaella* and *Wentzelophyllum* had already made their appearrance in the Upper Carboniferous age (or Middle Carboniferous?) somewhere in the central part of the Tethys sea, and then to have moved toward east and west in the early Permian, when the sea was greatly transgressive in general, after the world wide regression of the latest Carboniferous.

In any event the existence of apparently " bipolar " or far widely separated



Text-figure 21
Distribution of *Waagenophyllum*.

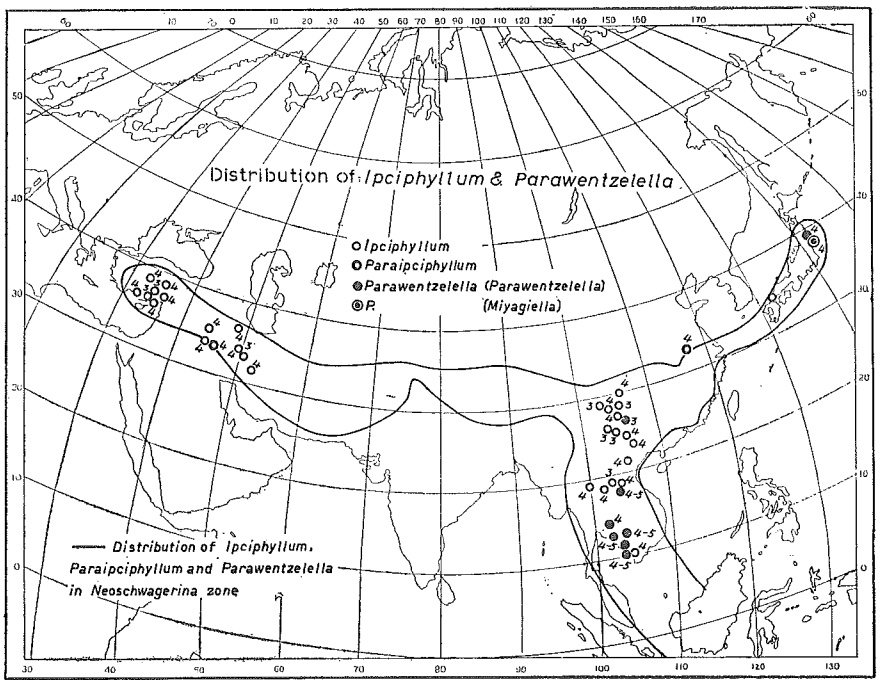
distribution of certain genera among Waagenophyllidae must be also worthy of note.

On the contrary, certain genera such as *Waagenophyllum* (*Waagenophyllum*), *Ipciphyllum*, *Akagophyllum* and *Polythecalis* show a rather wide range in geographical distribution except for the earliest species. Further, there are also such genera which have a generally wide extension in geographical distribution, while only being found in the western region of the Tethys sea province: *Pavastehphyllum* (s. str.), *Thomasiphyllum*, *Pseudohuangia*, *Paraipciphyllum*, *Wentzelellites*, and certain forms of so-called *Wentzelophyllum*, which are apparently very close to the Lower Carboniferous " *Stylidophyllum* ".

On the contrary the following genera are only known from the eastern region: *Chihsiaphyllum*, *Huayunophyllum*, *Miyagiella*, *Parawentzella*, *Maoriphyllum*, *Laophyllum*, and *Wentzelloides*.

While, the following forms are only known from the central region of the Tethys sea: *Pseudocarniaphyllum*, *Liangshanophyllum*, *Chaoiphyllum* and *Huangia*.

Thus, we have concisely dwelt on the most characteristic features recongnized in the distribution of waagenophyllid corals.

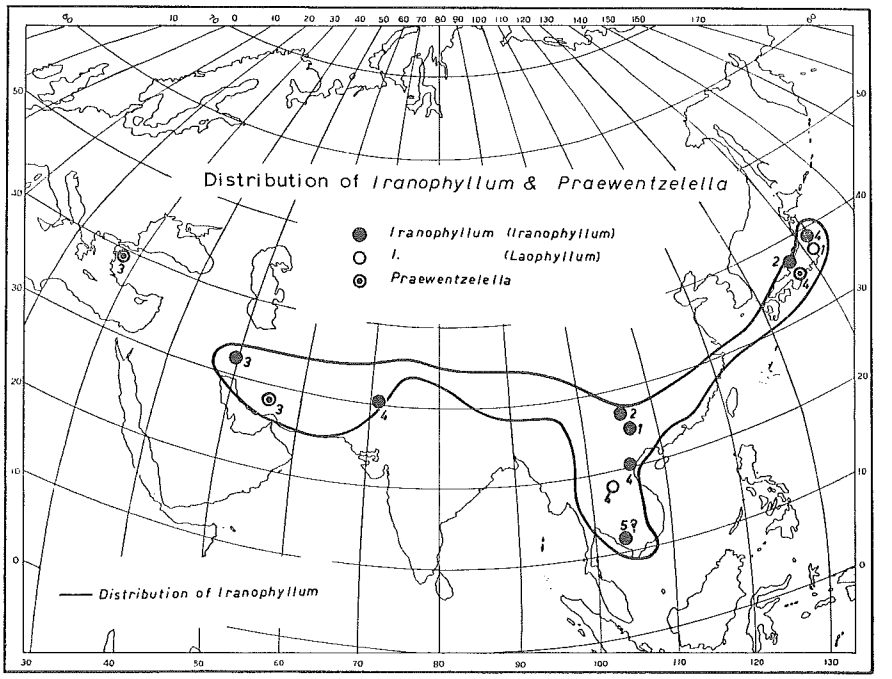


Text-figure 22
Distribution of *Ipciphyllum*, *Paraipciphyllum* and *Parawentzelella*.

All facts above mentioned seem to involve various interesting problems. Why did the ancestral form first appear in a rather limited region? Why were the Waagenophyllidae distributed only in the Tethys sea province? Why did certain genera became isolated in remote places from the central area of distribution? Why were certain genera only known from the western region. Why were certain forms distributed so widely etc. These are all quite interesting but difficult questions to answer.

Meanwhile, the western end of distribution of Waagenophyllidae is now situated at about 48°–43°N. Lat. Further, the nothern limit of distribution in the central area is now plotted at about 41°N. Lat. Thus, the coral sea in those days must have been extended far towards the north beyond the northern limit of distribution of the present compound corals.

Besides this, even though we have traced the Tethys sea regions from west to east where the waagenophyllid corals are abundantly found in the Permian coral sea region, it may have not been stretching perfectly along the equatorial plane viz. not perfectly parallel to any latitude lines of the present day. Nevertheless, the Tethys sea—Waagenophyllidae zoogeographical province of the

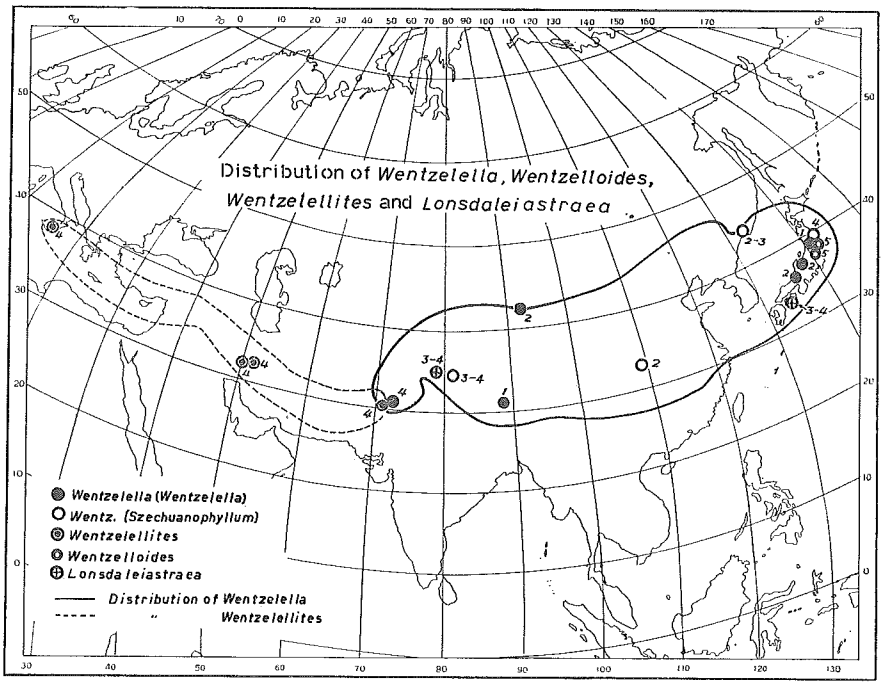


Text-figure 23
Distribution of *Iranophyllum* and *Praewentzelella*.

Permian—can be considered to have been the equatorial sea of those days. Under certain assumptions, pole wandering for instance, may be highly probable.

It must be noted however that the present geographical distribution of waagenophyllid corals may not well be explained by the equatorial current of those days alone as a result of tropical situation of the Tethys sea. Corals may have had chances to migrate over great distances by currents when they were in a larva stage. Accordingly, the westward distribution of many genera and subgenera in the Tethys sea can be understood to some extent by the assumption that the Tethys was an equatorial sea. However, the eastward geographical distribution of certain forms is not easily explained by the same assumption. At least the earlier forms for each bioseries seems to have first appeared somewhere in the central Tethys sea as stated in the foregoing pages. Instead of this, certain forms may possibly have moved eastward through the ages. This fact seems to be hardly explainable by the equatorial current which goes from east to west.

Of course, more time will be required to know all details of the true distribution of waagenophyllid corals. Thus, it would too early to seach our conclusions concerning the main distribution of corals.



Text-figure 24

Distribution of *Wentzelella*, *Wentzelloides*, *Wentzelellites* and *Lonsdaleiastraea*.

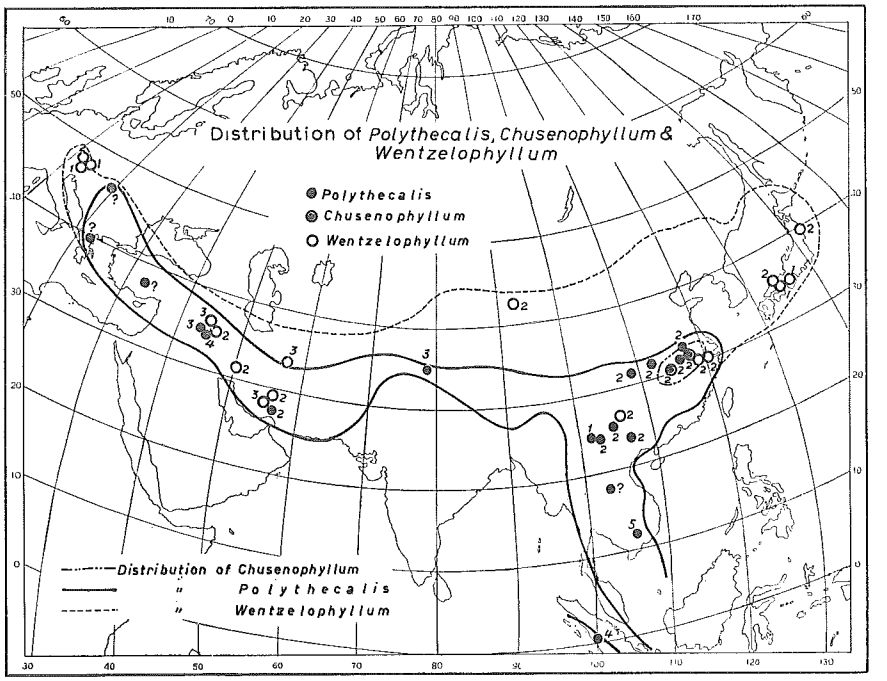
Further, even the eastward distribution of certain genera among Waagenophyllidae could have well resulted from other currents. Namely, if certain continents actually existed immediately north and south of the equatorial sea of those days, certain parts of equatorial currents may have branched and changed their direction from west to east, when they faced such continents.

Of course, the main part of the equatorial currents may have always moved from east to west, but certain branch currents may be regarded to have washed the shore from west to east along the old continent existing just north and south of the Tethys sea.

The palaeogeographical maps compiled by many geologists including the present anthors show the presence of such a continent in the Permian.

The central area of the Tethys sea (South Chinese Basin) shown in the series of palaeogeographical maps seems, however to have been so narrow or too limited to reasonably explain the eastward distribution of waagenophyllid corals by currents.

Thus, we must stand on another assumption that the palaeogeography of those days was actually different from what the palaeogeographical maps show. The



Text-figure 25

Distribution of *Polythecalis*, *Chusenophyllum* and *Wentzelophyllum*.

maps here were compiled by us by standard shore line tracing methods on the distribution of marine sediments.

We must accordingly introduce an assumption, in which the geographical position of continents became changed by " horizontal shifting " or " drifting " of the earth crust during the long duration of geological time.

Actually, a palaeomagnetic study gives us results indicating that certain parts of the Tethys sea was located far south from the present.*

And this fact seems to substantiate the existence of a " drifting " like movement of the crust in the past.

We do not wish, however, to step further into this problem in the present paper. Nevertheless, we do wish to point out that the geographical distribution of Waagenophyllidae is one of keys for a solution of a problem regarding the geo-

* MINATO, M. and FUJIWARA, Y.: Palaeomagnetism and palaeoclimatolog the Japanese islands, Proc. Japan Acad., vol. 40, no. 2, pp. 116–120, 1964.
MINATO, M. and FUJIWARA, Y.: Carboniferous palaeomagnetism of the Kitakami mountains, Northeastern Honshu, Japan, Compte Rendu 5e Congrès International des Stratigraphie et de géologie du Carbonifère, pp. 518–585, 1964.

logical development of sea and continent.

Lastly, we should like to place special stress on the fact, that the distribution of waagenophyllid corals also involves taxonomical importance on the other side.

Namely, some scientists refuse to admit the generic difference in general between solitary, fasciculate and massive forms, when their fundamental structures of skeleton are not much different from each other.

However, our results show the immense difference in geological and geographical distributions, among solitary, fasciculate or massive forms, even though there is a close resemblance in the morphology of the corallite. For instance, *Pavastehphyllum*, *Waagenophyllum* (*Waagenophyllum*), *Ipciphyllum* have a strong resemblence in their fundamental morphology in corallites. Nevertheless, they show a quite different distribution from a geological and geographical point of view. Their generic independence is thus beyond doubt.

7) PHYLOGENY OF WAAGENOPHYLLIDAE

A phylogenetic tree, needless to say, should reasonably illustrate the true affinities between genera and subgenera contained in a group, together with their geological distributions and especially the time of their first appearances.

While there are some problematical forms which cannot be correctly identified, only one species belonging to Waagenophyllidae has been known so far from the middle Carboniferous. All remaining forms of the family belong to the Permian.

As the family already had many divergent stocks in the early Permian time, one might suspect that the group is polyphyletic in origin.

However, the group invariably has clinotabulae and elongate dissepiments —though they differ in degree of development—and thus doubtlessly constitute a distinct family.

Therefore we have reconstructed the phylogeny of Waagenophyllidae, based on the assumption that the group was derived from a certain, single ancestor in pre-Moscovian time, which was not of polyphyletic origin.

Next, the family Waagenophyllidae is further divisible into two major subgroups—Waagenophylliane and Wentzelellinae—in accordance with the absence or the development of three or more orders of septa. Actually the former includes a rather exceptional genus, in which sporadical tertiary septa are rarely detectable. However, this genus is a derivative of *Ipciphyllum*, and it seems reasonable to attribute the genus to Waagenophyllinae rather than to Wentzelellinae, judging also from other internal characteristics.

In short, it is evident that there are two major subgroups in Waagenophyllidae, one in which septa of higher orders are dominant, while being absent in the other.

The earliest known genus, Moscovian *Huangia*, belongs to Waagenophyllinae. Therefore the branching of Waagenophyllinae and Wentzelellinae from an common ancestor might have taken place as early as Pre-Moscovian time.

Thirdly, each subfamily contains solitary, fasciculate and massive forms. The taxonomic significance of these three growth forms has already been described in a previous chapter on geographical distribution of Waagenophyllidae. The oldest known form of the family, *Huangia* is a fasciculate form. Thus it is assumed that the branching of these three growth forms might also have taken place in pre-Moscovian time at least in the case of Waagenophyllinae.

Nothing definite is, of course, known concerning Wentzelellinae. However, a similar branching of three growth forms may be expected to have occurred in the subfamily after the branching of Waagenophyllinae and Wentzelellinae from an common ancestral form.

If both subfamilies were derived from a single ancestral stock, and if each subfamily were further divided into three forms in the Carboniferous, as above stated, we may consider that this will suffice to explain the fact that representatives of each solitary, fasciculate and massive forms of both subfamilies had already appeared in early Permian.

However, it should be noted that fasciculate Wentzelellinae is not known in the early Permian. *Praewentzelella*, a representative of fasciculate Wentzelellinae appeared first in *Pseudofusulina* zone.

As many species have been known to date in Waagenophyllidae, and as the geological range has been clarified to a certain extent, it is relatively easier to establish the phyletic relationship between many Permian forms, as compared against a similar task for Carboniferous, although there may be many " missing links " left from the present consideration.

Phylogeny of Waagenophyllidae shown in text-fig. 26 is based on the consideration made on morphological affinities between species, subgenera and genera belonging to solitary, fasciculate and massive forms, combined with the data of their stratigraphic distribution.

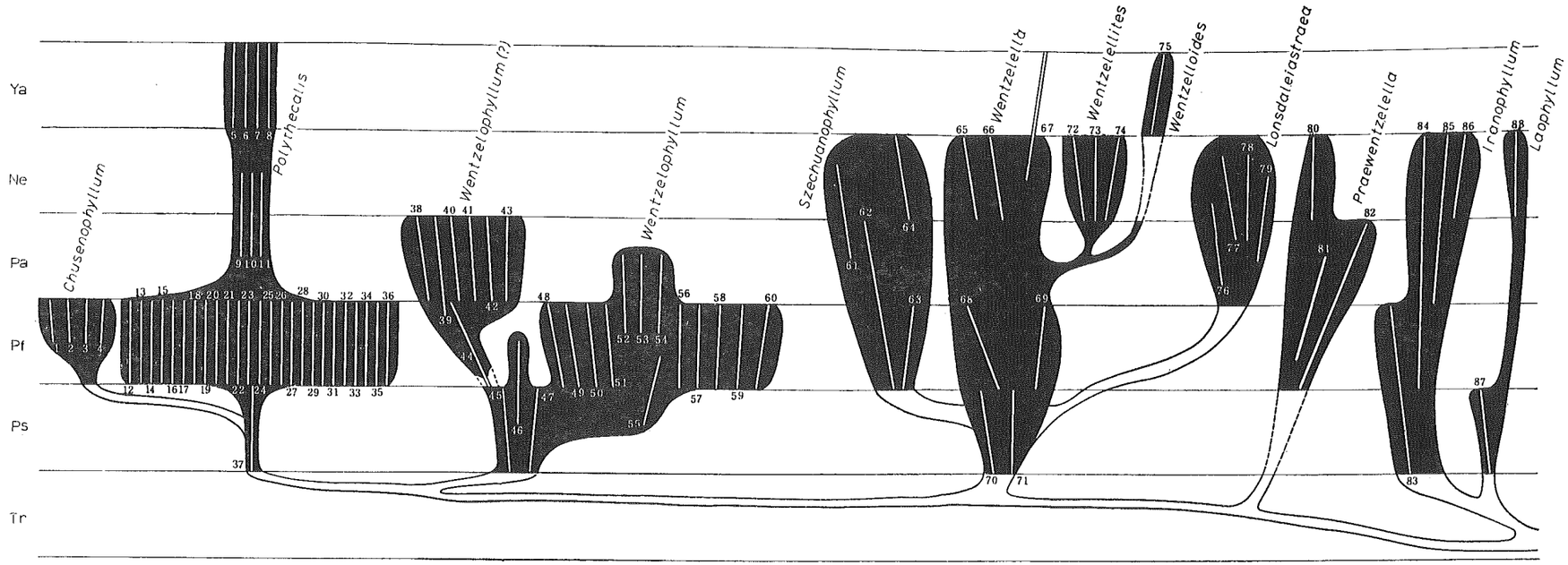
Evolutional trends already discussed are to some extent, indicated in this phylogenetic tree. And also it is well shown that specialized forms have a short geological range, and appeared later, compared to forms with relatively primitive characteristics. The occurrence of *Yokoyamaella*, *Wentzelophyllum* and *Polythecalis* in the early Permian may seem to contradict the fact that they look rather specialized. (As described in the chapter of systematics, *Polythecalis* is not thoroughly reviewed in the present study. Some younger " *Polythecalis* " may be better removed from the genus proper.) However these three genera are commonly characterized in having septal wall which often vanishes; and individual corallites are connected by septa and common dissepiments. Originally the wall is extremely thin in these genera, and it is replaced by specialized septa

Text-figure 26

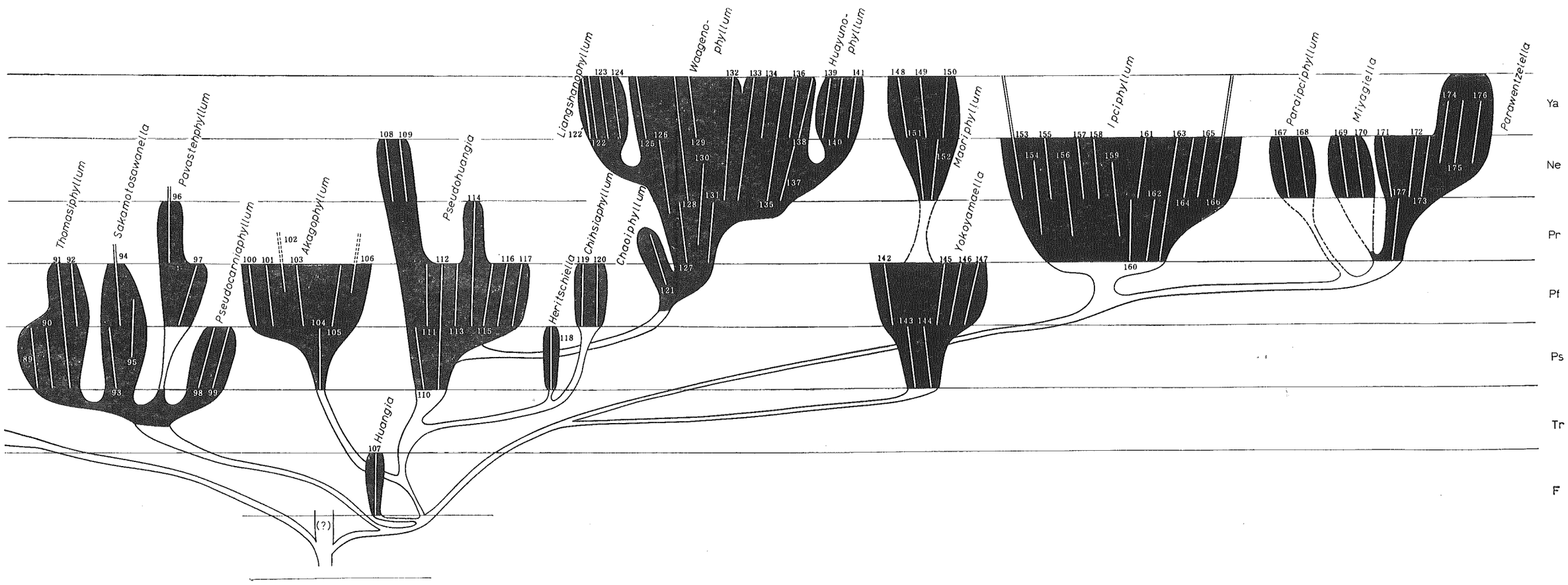
Phylogeny of Waagenophyllidae.

1. *Chusenophyllum paeonoidea* TSENG
2. *C. asteroidea* TSEND
3. *C. tungliangensis* (YÜ in HUANG)
4. *C. breviseptatum* TSENG
5. *Polythecalis* ? *bauryi* FONTAINE
6. *P.* ? *khmerianus* FONTAINE
7. *P·* ? *regularis* FONTAINE
8. *P.* ? *biformis* FONTAINE
9. *Polythecalis frechi* (VOLZ)
10. *P. variabilis* (GERTH)
11. *P.* ? sp. (HUDSON, 1958)
12. *P. chinensis* (GIRTY)
13. *P. confluens* YABE et HAYASAKA
14. *P. verbeekielloides* HUANG
15. *P. rosiformis* HUANG
16. *P. multicystosis* HUANG
17. *P. yangtzeensis* HUANG
18. *P. hochowensis* HUANG
19. *P. polygonalis* HUANG
20. *P. chinmenensis* HUANG
21. *P.* ? *langpoensis* HUANG
22. *P. dupliformis* HUANG
23. *P. flatus* HUANG
24. *P. grayi* DOUGLAS
25. *P.* ? *huangi* TSENG
26. *P.* ? *wangi* TSENG
27. *P.* ? *hexagonalis* TSENG
28. *P.* ? *nankingensis* TSENG
29. *P. simplex* ZHAO et CHEN
30. *P. irregularis* ZHAO et CHEN
31. *Polythecalis denticulatus* (HUANG)
32. *P. yangtzeensis crassiseptata* ZHAO et CHEN
33. *P. abnormis* ZHAO et CHEN
34. *P.* sp. (=*P. regularis* ZHAO et CHEN. non FONTAINE)
35. *P. minor* ZHAO et CHEN
36. *P. choxiansis* ZHAO et CHEN
37. *P.* sp. (=*Stylidophyllum* sp., CHI, 1931)
38. *Wentzelophyllum* ? *persicum* (DOUGLAS)
39. *W.* ? *gelikhanense* MINATO et KATO
40. *W.* ? *jenningsi* (DOUGLAS)
41. *W.* ? *orientale* (DOUGLAS)
42. *W.* ? *douglasi* MINATO et KATO
43. *W.* ? *tabasense* MINATO et KATO
44. *W.* ? *langpotangense* MINATO et KATO
45. *Wentzelophyllum felseri* MINATO et KATO
46. *W. arminiae* (FELSER)
47. *W. kinkiense* (SAKAGUCHI et YAMAGIWA)
48. *W. intermedium* (HUANG)
49. *W. chaoi* (HUANG)
50. *W. huayunshanense* (TSENG)
51. *W. kueichowense* (HUANG)
52. *W. kueichowense* var. *alpha* (DOUGLAS)
53. *W. kueichowense* var. *beta* (DOUGLAS)
54. *W.* cfr. *kueichowense* (HUANG)
55. *W. eguchii* (YOKOYAMA)
56. *W. volzi* (YABE et HAYASAKA)
57. *W. volzi* mut. *alpha* (HUANG)
58. *W. volzi* mut. *beta* (HUANG)
59. *W. volzi* mut. *gamma* (HUANG)
60. *W. hayasakai* MINATO et KATO
61. *Wentzelella* (*Szechuanophyllum*) *caracorumensis* GERTH
62. *W.* (*S.*) *szechuanensis* var. (FOMITCHEV)
63. *W.* (*S.*) *szechuanensis* HUANG
64. *W.* (*S.*) *kitakamiensis* YABE et MINATO
65. *Wentzelella* (*Wentzelella*) *wynnei* (WAAGEN et WENTZEL)
66. *W.* (*W.*) *salinaria* (WAAGEN et WENTZEL)
67. *W.* (*W.*) *regularis* FONTAINE
68. *W.* (*W.*) *simplex* YÜ et LIN
69. *W.* (*W.*) *osobudaniensis* IGO
70. *W.* (*W.*) *salinaria* (WAAGEN et WENTZEL) var.
71. *W.* (*W.*) sp.
72. *Wentzelellites sicula* (GALLITELLI)
73. *W. senni* MINATO et KATO
74. *W. harrisoni* (DOUGLAS)
75. *Wentzelloides maiyaensis* YABE et MINATO
76. *Lonsdaleiastraea yamanbaensis* MINATO
77. *L. vinassai* GERTH
78. *L. molengraafi* (GERTH)
79. *L. typica* GERTH
80. *Praewentzelella honjoi* MINATO et KATO
81. *P. magnifica* (DOUGLAS)
82. *P. multiseptata* (ENDERLE)
83. *Iranophyllum* (*Iranophyllum*) *amygdalophylloideum* (HUANG)
84. *I.* (*I.*) *tunicatum* IGO
85. *I.* (*I.*) *splendens* DOUGLAS
86. *I.* (*I.*) *indicum* (DE KONINCK)
87. *I.*(*Laophyllum*)*nakamurai* MINATO et KATO

88. *I.* (*L.*) *pongouaense* (MAHSUY)
89. *Pavastehphyllum* (*Thomasiphyllum*) *reticulatum* (DOUGLAS)
90. *P.* (*T.*) *nantanense* (YÜ)
91. *Pavastehphyllum* (*Thomasiphyllum*) *arachnoides* (DOUGLAS)
92. *P.* (*T.*) *spongifolium* (SMITH)
93. *P.* (*Sakamotosawanella*) *permicum* (CHI)
94. *P.* (*S.*) *carcinophylloides* (DOUGLAS)
95. *P.* (*S.*) *sakamotosawanum* M. et K.
96. *P.* (*Pavastehphyllum*) *simplex* (DOUGLAS)
97. *P.* (*P.*) *nontabulatum* (HUANG)
98. *P.* (*Pseudocarniaphyllum*) *orientale* WU
99. *P.* (*P.*) *convexum* WU
100. *Akagophyllum* sp. (DOUGLAS)
101. *A. parachihsiaense* (HUANG)
102. *A. hasegawai* MINATO et KATO
103. *A. akagoense* (OZAWA)
104. *A. tibeticum* (REED)
105. *A. yabei* MINATO et KATO
106. *A. nogamie* (YAMAGIWA)
107. *Huangia chütsingensis* CHI
108. *Pseudohuangia counilloni* (MANSUY)
109. *P. cincta* (DOUGLAS)
110. *P. minima* (DOUGLAS)
111. *P. persica* (DOUGLAS)
112. *P. chitralica* (SMITH)
113. *P. tabellata* (DOUGLAS)
114. *P. stoecklini* MINATO et KATO
115. *P. chiuyaoshanensis* (HUANG)
116. *P. lipoensis* (HUANG)
117. *P. tsengi* (ZHAO et CHEN)
118. *Heritschiella girtyi* (MOORE et JEFFORDS)
119. *Chihsiaphyllum diphyphylloideum* (HUANG)
120. *C. chihsiaense* (YOH)
121. *Waagenophyllum* (*Chaoiphyllum*) *chaoi* MINATO et KATO
122. *W.* (*Liangshanophyllum*) *lui* TSENG
122.. *W.* (*L.*) *sinense* WU
123. *W.* (*L.*) *stereoseptatum* TSENG
124. *W.* (*L.*) *wui* MINATO et KATO
125. *W.* (*Waagenophyllum*) *huangi* DOUGLAS
126. *W.* (*W.*) *kueichowense* HUANG
127. *W.* (*W.*) *longiseptatum* TSENG
128. *W.* (*W.*) *polyseptatum* MINATO
129. *W.* (*W.*) *simplex* WU
130. *W.* (*W.*) *wengchengense* HUANG
131. *W.* (*W.*) *yunnanense* CHI
132. *W.* (*W.*) *indicum* (WAAGEN eEt WNTZEL)
133. *W.* (*W.*) *virgalense* (WAAGEN et WENTZEL)
134. *W.* (*W.*) *akasakense* (YABE)
135. *W.* (*W.*) *pulchrum* HAMADA
136. *W.* (*W.*) *compactum* MINATO et KATO
137. *W.* (*W.*) *smithi* MINATO et KATO
138. *W.* (*W.*) *novaezelandiae* LEED
139. *W.* (*Huayunophyllum*) *aequitabulatum* TSENG
140. *W.* (*H.*) *teratoideum* (FONTAINE)
141. *W.* (*H.*) *kanense* (KAWANO)
142. *Yokoyamaella* (*Yokoyamaella*?) *kaludjeracensis* MINATO et KATO
143. *Y.* (*Y.*) *carinthiaca* (HERITSCH)
144. *Y.* (*Y.*) *stillei* (HERITSCH)
145. *Y.* (*Y.*) *yokoyamai* (OZAWA)
146. *Y.* (*Y.*) *tertioseptata* (YOKOYAMA)
147. *Y.* (*Y.*) *kurohime* MINATO et KATO
148. *Y.* (*Maoriphyllum*) *maoria* (LEED)
149. *Y.* (*M.*) *nishinense* (YAMAGIWA)
150. *Y.* (*M.*) *minense* MINATO et KATO
151. *Yokoyamaella* (*Maoriphyllum*) *matsushitae* (YAMAGIWA)
152. *Y.* (*M.*) *ozawai* (MINATO)
153. *Ipciphyllum laosense* (PATTE)
154. *I. heritschi* MINATO et KATO
155. *I. irregularis* FONTAINE
156. *I. timoricum* (GERTH)
157. *I. subtimoricum* (HUANG)
158. *I. kwangsiense* WU
159. *I. persicum* (DOUGLAS)
160. *I. elegans* (HUANG)
161. *I. subelegans* MINATO et KATO
162. *I. gnomeiense* (HUANG)
163. *I. huangi* MINATO et KATO
164. *I. flexuosum* (HUANG)
165. *I. anatolicum* (FLÜGEL)
166. *I. simplex* WU
167. *Paraipciphyllum elegantum* WU
168. *P. hudsoni* MINATO et KATO
169. *Parawentzelella* (*Miyagiella*) *motoyoshiensis* MINATO et KATO
170. *P.* (*M.*) *miyagiensis* MINATO et KATO
171. *P.* (*Parawentzelella*) *gubleri* FONTAINE
172. *P.* (*P.*) *iwaizakiensis* (YABE et MINATO)
173. *P.* (*P.*) *regularis* FONTAINE
174. *P.* (*P.*) *socialis* (MANSUY)
175. *P.* (*P.*) *sisophonensis* FONTAINE
176. *P.* (*P.*) *canalifera* (MANSUY)
177. *P.* (*P.*) *paracanalifera* (HUANG)



Phylogeny of Waagenophyllidae



(mural septa). Consequently, in terms of the thickness of walls these three genera may be considered as representatives of extremely thin wall type compared to later forms of massive Waagenophyllidae. Thus a trend from thin to thick walls is orthogenetically maintained in these three genera of early Permian.

8) STRATIGRAPHIC ZONATION

There are numerous species belonging to Waagenophyllidae, whose geological range is very short. This fact may be easily understood by the figure showing the phylogeny of this group of corals. Further, certain genera or subgenera or Waagenophyllidae seem actually to have been geologically so short in range as some genera of Fusulinidae. The following forms, for instance, may be enumerated below in respect to the zonation of the Permian, besides Middle Carboniferous.

Huangia = *Fusulinella—Fusulina* zone

Pseudocarniaphyllum
Heritschiella = *Pseudoschwagerina* zone

Chihsiaphyllum
Chusenophyllum = *Pseudofusulina* zone

Chaoiphyllum = *Parafusulina* zone

Miyagiella
Paraipciphyllum = *Neoschwagerina* zone
Wentzelellites

Liangshanophyllum
Huayunophyllum = *Yabeina* zone
Wentzelloides

All of the genera mentioned above have been, however, only locally found until the present. Thus they may not be suitable for regional or international correlation.

Next we should like to consider whether good horizon indicators may actually be found among forms with a geographically wider extent of distribution.

As a matter of fact, such forms can hardly be found, because most of the wider geographical forms show a relatively longer geological range in general.

Instead of this the representative age of certain genera sometimes relatively short in regard to the number of species appearing, although the generic range itself is somewhat longer than the most prosperous time.

For instance, *Akagophyllum*, *Pseudohuangia*, *Yokoyamaella*, *Polythecalis* and *Wentzelophvllum* are especially rich in species in the *Pseudofusulina* zone, while *Ipciphyllum* is relatively abundant in the *Neoschwagerina* zone. Further, in *Waagenophyllum* (s. str.) the species gradually increase upwards from the *Parafusu-*

lina zone, but are eventually richest in the *Yabeina* zone.

Accordingly, these genera above enumerated can be regarded as good horizon markers for each zone represented by respective fusulinid genus.

As to the *Parafusulina* zone, suitable coral genera can hardly be found for zonation. However, it is worthy of note that this age was the stage in which the older genera of the Permian such as *Akagophyllum*, *Wentzelophyllum*, *Polythecalis*, *Yokoyamaella* and *Pseudohuangia* rapidly decreased or became extinct, while such newer forms as *Waagenophyllum* (s. str.), *Ipciphyllum*, *Parawentzelella* and *Lonsdaleiastraea* were showing a rising trend.

The *Pseudoschwagerina* zone is characterized by the earlier forms for each genus or subgenus, although it is not represented by any genera of limited geological range, inspite of its wide geographical extent in distribution. Such solitary forms as *Iranophyllum*, *Laophyllum*, *Thomasiphyllum*, *Sakamotosawanella* and *Pseudocarniaphyllum*, besides *Akagophyllum*, *Pseudohuangia*, *Yokoyamaella*, *Polythecalis*, *Wentzelophyllum* and *Wentzelella* for instance have their own representatives for this age. Among them, *Pavastehphyllum* (s.l) may be worthy of note, because within 11 species belonging to this genus, 7 species belonging to three subgenera, *Thomasiphyllum*, *Sakamotosawanella* and *Pseudocarniaphyllum* had already made their appearance at the dawn of the Permian.

Thus, the zonation based on Waagenophyllidae can be summarized as follows:

Huangia zone = Middle Carboniferous, *Fusulinella—Fusulina* zone
Pavastehphyllum (s.l.) zone = *Pseudoschwagerina* zone
Akagophyllum, *Polythecalis* and *Wentzelophyllum* zone = *Pseudofusulina* zone
Pseudohuangia and *Lonsdaleiastraea* zone = *Parafusulina* zone
Ipciphyllum zone = *Neoschwagerina* zone
Waagenophyllum zone = *Yabeina* zone

PART 2. CLASSIFICATION OF WAAGENOPHYLLIDAE

Phylum COELENTERATA
Class ANTHOZOA EHRENBERG, 1834
Subclass ZOANTHARIA DE BLAINVILLE, 1830
Order RUGOSA MILNE-EDWARDS & HAIME, 1850

Family **WAAGENOPHYLLIDAE** WANG, 1950

(nom. transl. HUDSON, 1958) (ex Waagenophyllinae WANG, 1950)
1950 Waagenophyllinae WANG, p. 212
1956 Waagenophyllinae HILL, F. 309
1958 Waagenophyllidae HUDSON, p. 177
1961 Wagenophyllinae FONTAINE, p. 163

Solitary or compound rugosa with two or more orders of septa. Septa diffuso-trabecular, may be carinated, vesicular, or even naotic. Axial column generally has a round outline. Tabularium consists of transverse tabulae which may be largely replaced by clinotabulae. Dissepiments develop in various degrees, including elongate and lonsdaleoid ones as well as normal globose dissepiments. Remarks: There are sometimes found species without lonsdaleoid dissepiments among Waagenophyllidae, but such type of dissepiments seems to generally develop in various degrees in almost all the genera of this family. The presence or absence of lonsdaleoid dissepiments cannot accordingly be regarded to be of prime importance to separate Waagenophyllidae from Lonsdaleidae.

Next, clinotabulae and elongate dissepiments may have been long thought to be quite adequate to distinguish waagenophyllids from the other group of corals, and this is true indeed. However, even clinotabulae are the structures found not only in Waagenophyllidae but also in certain forms of Carboniferous corals: *Lonsdaleia siblyi* SMITH for example. We do know similar case in some Japanese Carboniferous corals, also*. Therefore, the development clinotabulae cannot be viewed solely to be a conclusive criterion to distinguish Waagenophyllidae from other coral families.

In reality, there are many cerioid waagenophyllids with lonsdaleoid dissepiments, which are hardly distinguishable from the Lower Carboniferous *Actinocyathus*** in general form of corallites. They may be, however, homeomorphic in origin.

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* *Taisyakuphyllum, Lonsdaleoides* etc.

** " *Stylidophyllum,*" a genus for cerioid *Lonsdaleia.*

Further, it must be fully understood that clinotabulae as well as elongate dissepiments are well developed in all waagenophyllid corals without exception, as before stated. On the contrary such structures are rather uncommon in Lonsdaleidae, though not completely lacking.

In addition, tertiary and sometimes even quaternary setpa are often found in Waagenophyllidae, but they are absolutely unknown in Lonsdaleidae.

Thus, to separate Waagenophyllidae from Lonsdaleidae as a distinct family from each other may be justified. In this regard we completely agree with HUDSON (1958).

Next, how to divide the Waagenophyllidae is a problem. The classification based on growth forms such as solitary, fasciculate or massive ones, which was adopted by HUANG (1932) and subsequently by FONTAINE (1961) seems to be quite convenient, and we were once nearly inclined to follow them in the course of the present study.

However, HUDSON's proposal to classify Waagenophyllidae into two major divisions, such as Wentzelellinae and Waagenophyllinae, based on the nature of septa (orders of septa) seemed later to be more reasonable from the view point of taxonomy and we also wish to follow him in this respect.

SYNOPSIS OF THE CLASSIFICATION OF WAAGENOPHYLLIDAE

Family Waagenophyllidae WANG
- Subfamily Waagenophyllinae WANG
  - Waagenophyllidae without tertiary or more oders of septa.
  - Solitary forms
    - Genus *Pavastehphyllum* nov.
      - Subgenus *Pavastehphyllum* nov. Skeletal structures are thin.
      - Sdbgenus *Sakamotosawanella* nov. Septa are thick.
      - Subgenus *Thomasiphyllum* nov. Septa are vesicular.
      - Subgenus *Pseudocarniaphyllum* WU Lonsdaleoid dissepiments are well developed.
  - Fasciculate forms
    - Genus *Huangia* YABE Lonsdaleoid dissepiments present. Minor septa are short.
    - Genus *Akagophyllum* nov. Lonsdaleoid dissepiments present. Minor septa are long. Skeletal structures are sometimes considerably thickened.
    - Genus *Heritschiella* MOORE et JEFFORDS Lonsdaleoid dissepiments absent. Proper dissepimentarium is wide. Elongate dissepiments are less well developed. Axial structure is rather compact.
    - Genus *Pseudohuangia* nov. Lonsdaleoid dissepiments absent. Elongate

dissepiments are not well developed.

Genus *Waagenophyllum* HAYASAKA Lonsdaleoid dissepiments absent.

Subgenus *Waagenophyllum* HAYASAKA Elongate dissepiment greatly developed. Transverse tabulae narrow and sparse.

Subgenus *Chaoiphyllum* nov. With diphyphylloid axial structure.

Subgenus *Liangshanophyllum* TSENG Elongate dissepiments present. Clinotabularium broad. Transversd tabulae broad.

Subgenus *Huayunophyllum* TSENG Elongate dissepiments largely developed. Axial structure simple.

Genus *Chihsiaphyllum* nov. With aulos like axial structure.

Massive forms (mainly cerioid)

Genus *Yokoyamaella* nov. Septal walls are very thick. Axial structure is rather compactly constructed.

Subgenus *Yokoyamaella* nov. Corallum cerioid.

Subgenus *Maoriphyllum* nov. Corallum partly thamnastraeioid.

Genus *Ipciphyllum* Hudson Corallum cerioid. Walls are thin. Lonsdaleoid dissepiments may develop.

Genus *Parawentzelella* FONTAINE Quite similar to the preceding genus, but with the development of canals.

Subgenus *Parawentzelella* FONTAINE Without lonsdaleoid dissepiments

Subgenus *Miyagiella* nov. With fairly well developed lonsdaleoid dissepiments.

Genus *Paraipciphyllum* WU Walls partly disappear but without canals.

Subfamily Wentzelellinae HUDSON Waagenophyllidae with tertiary or more orders of septa.

Solitary forms

Genus *Iranophyllum* DOUGLAS

Subgenus *Iranophyllum* DOUGLAS Lonsdaleoid dissepiments absent.

Subgenus *Laophyllum* FONTAINE Lonsdaleoid dissepiments present.

Fasciculate forms

Genus *Praewentzelella* nov. Lonsdaleoid dissepiments absent.

Massive forms

Genus *Wentzelella* GRABAU Corallum cerioid.

Subgenus *Wentzelella* GRABAU Lonsdaleoid dissepiments almost wholly lacking.

Subgenus *Szechuanophyllum* WANG With fairly well developed lonsdaleoid dissepiments.

Genus *Wentzelloides* YABE et MINATO Corallum meandroid. Axial structure is rather compact, and small. Lonsdaleoid dissepiments are not well developed.

Genus *Wentzelellites* WU Corallum thamnastraeoid.
Genus *Lonsdaleiastraea* GERTH Corallum thamnastraeioid, and partly aphroid. Axial structure is similar to the above genus.
Genus *Wentzelophyllum* HUDSON Corallum cerioid. Lonsdaleoid dissepiments are well developed.
Wentzelophyllum HUDSON (s.str.) Walls are bead shaped or denticulated. Tertiary septa are long, compared to the next group.
Wentzelophyllum?? Walls are thin. Tertiary septa are incipient, only represented by some spines on walls.
Genus *Polythecalis* YABE et HAYASAKA Corallum semi-aphroid.
Genus *Chusenophyllum* TSENG Corallum aphroid.

Subfamily **Waagenophyllinae**, WANG 1950

(I. Solitary forms)

Genus ***Pavastehphyllum*** nov.

Type species: *Iranophyllum simplex* DOUGLAS, 1936
Diagnosis: Solitary Waagenophyllidae without 3 or more orders of septa. Londaleoid dissepiments may occur sporadically. Major septa may become vesciular.
Geologic distribution: *Pseudoschwagerina* to *Parafusulina* zone.
Geographic distribution: Iran (Baluchistan), Tibet, Burma, China, Viet-Nam and Japan.
Included subgenera and species:

Subgenus *Pavastehphyllum* nov.
Pavastehphyllum (*Pavastehphyllum*) *simplex* (DOUGLAS), 1936
Pav. (*Pav.*) *nontabulatum* (HUANG), 1932

Subgenus *Sakamotosawanella* nov.
Pavastehphyllum (*Sakamotosawanella*) *samotosawanum* nom. nov.
Pav. (*Sak.*) *permicum* (CHI), 1938
Pav. (*Sak.*) *carcinophylloides* (DOUGLAS), 1936

Subgenus *Thomasiphyllum* nov.
Pavastehphyllum (*Thomasiphyllum*) *spongifolium* (SMITH), 1940
Pav. (*Thom.*) *arachnoides* (DOUGLAS), 1950

Pav. (*Thom.*) *reticulatum* (DOUGLAS), 1950
Pav. (*Thom.*) *nantanense* (YÜ), 1934

Subgenus *Pseudocarniaphyllum* WU, 1962
Pav. (*Pseudocar.*) *orientale* (WU), 1962
Pav. (*Pseudocar.*) *convexum* (WU), 1962

Remarks: The present new genus includes all solitary waagenophyllids not having tertiary septa. Accordingly, it is quite distinct from the genus *Iranophyllum*.

We discriminate four subgnera in this genus. It may be highly probable that the present genus is polyphyletic in origin.

Carniaphyllum HERITSCH 1936 appears to be a simple waagenophyllid. It resembles *Iranophyllum* in the general mode of corallite, although it has no tertiary septa, besides its longitudinal nature is unknown. Should one consider it as a waagenophyllid, *Pavastehphyllum* comes to be a junior synonym of *Carniaphyllum*.

But, the septa of *Carniaphyllum* are thick in their medial part, tapering at both axial and peripheral ends, so that the feature seems to be quite the same as that of clisiophyllid or dibunophyllid corals in the Carboniferous. Further, the counter septum of the genus *Carniaphyllum* directly extends into the axial column and unites with the median plate. Thus, the similarity between *Carniaphyllum* and the present genus seems to be only superficial, and there cannot be any intimate relation between them.

Subgenus ***Pavastehphyllum*** nov.

Type species: *Iranophyllum simplex* DOUGLAS, 1936
Diagnosis: Skeletons of this group of corals are all notably thin. Sporadical lonsdaleoid dissepiments are only indicated by the discontinuation of minor septa between major septa in dissepimentarium. Elongate dissepiments may be rather less inclined. Corallites are small in general.

Pavastehphyllum* (*Pavastehphyllum*) *simplex (DOUGLAS)

1936 *Iranophyllum simplex* DOUGLAS, p. 19, pl. 1, figs. 6a, b.
Holotype: No. S.P.R. 1514.
Type locality: Pavasteh, Bakhtiari country, Iran.
Geological age: Permian (*Polydiexodina* zone—*Neoschwagerina* zone). Associated fauna: *Polydiexodina persica* KAHLER, " *Stylidophyllum* " *kueichowense* HUANG, *Yatsengia asiatica* HUANG, *Michelina siyangense* REED, *Polypora* cfr. *biarmica* KEYSERLING, *Buxtonia* cf. *juresanensis* (TSCHERN.)

Pavastehphyllum* (*Pavastehphyllum*) *nontabulatum (HUANG)

1932 *Dibunophyllum nontabulatum* HUANG, p. 47, pl. 2, figs. 17.
Holotype: No, 3850, V. K. TING collection.
Type locality: Tashihpan, Tatinghsien, Kueichow, China.
Geological horizon: Chihsia limestone, Permian.

Remarks: The species was described to have no tabulae, and HUANG assumed that this might represent a new genus. The general appearance of this coral closely resembles the preceding species. And close examination on HUANG's illustration of this species of *nontabulatum* (pl. 2, fig. 17b) reveals a trace of clinotabulae. Hence the transfer of this species from *Dibunophyllum* to *Pavastehphyllum* may well be justified.

Subgenus ***Sakamotosawanella*** nov.

Type species: *Iranophyllum carcinophylloides*, DOUGLAS, 1936

Diagnosis: This subgenus is characterized by thick septa in tabularia. In dissepimentaria on the other hand septa are very thin. This nature of intrathecal dilation also makes the inner wall very clear.

Pavastehphyllum* (*Sakamotosawanella*) *carcinophylloides (DOUGLAS)

1936 *Iranophyllum carcinophylloides* DOUGLAS, p. 19, pl. 1, figs. 7, 7a.
Holotype: No. S.P.R. 863
Type locality: Tapileh valley, Iran.
Geological horizon: Permian. The species was found with *Iranophyllum splendens*. DOUGLAS (1936) conjectured that the horizone yielding *Iranophyllum* was lower than the one with *Polydiexodina persica*, hence it can be regarded to denote the *Pseudofusulina* zone.

Remarks: Specimen described by DOUGLAS (1950) from south Iran is not *carcinophylloides* as will be stated later. SMITH (1940) described some specimens refering to the species from Burma, but his identification might not be correct, owing to difficulties caused by the fragmentary nature of the Burmese specimens.

Pavastephyllum* (*Sakamotosawanella*) *sakamotosawanum, nom. nov.
pl. 4, figs. 5, 6

1944 *Sakamotosawanella permicua* (sic) MINATO, nom. nud. p. 84

1955 *Iranophyllum permicum* MINATO, p. 115, pl. 31, fig. 4, pl. 39, fig. 3. non *Carcinophyllum? permicum* CHI, 1938, p. 172
Holotype: U.H.R. No. 15527, Sapporo, Japan. (erroneously numbered as 15519, in 1955)
Paratype: UHR. 15519
Type locality: Sasizawa, Maiya-machi, Miyagi Prefecture, Japan.
Geological horizon: Kawaguchi stage, Lower Sakamotozawa series (*Pseudofusulina* or *Pseudoschwagerina* zone).

Remarks: Owing to the lack of a well oriented longitudinal section, there is a slight doubt that the species can be safely assigned into the genus *Pavastehphyllum*.

In the holotype figured by MINATO (1955) there is no peripheral zone free from septa. But the paratype obtained from the same horizon at the same locality reveals small lonsdaleoid dissepiments developing at a site a little apart from the epitheca. So, in this regard this species is rather mutable.

Pavastehphyllum* (*Sakamotosawanella*) *permicum (CHI)

1938 *Carcinophyllum? permicum* CHI, p. 172, pl. 2, figs. 1a–b
1961 *Iranophyllum* sp., FONTAINE, p. 195, p. 5, figs. 5, pl. 23, figs. 8
Non *Iranophyllum permicum* MINATO 1955, p. 115
Type locality: 1 1/2 li northwest of Lungtan, south by east of Kuangnanhsien, southeast Yunnan, China.
Geological horizon: Maping limestone (*Pseudoschwagerina* zone).

Remarks: It is beyond doubt that this species is a typical waagenophyllid because of the nature of the coral in having clear clinotabulae and not having lonsdaleoid dissepiments. FONTAINE (1961) mentioned the occurrence of " *Carcinophyllum* " *permicum* in Sakmarian of Viet-Nam, but he did not give either description or illustration. On the other hand his *Iranophyllum* sp. from North Viet-Nam (pl. 5, fig. 5; pl. 23, fig. 8) closely resembles *Pavastehphyllum permicum*, and also has some resemblance to *Pavastehphyllum carcinophylloides*. The horizon of this Viet-Nam specimens is again unfortunately known only as Permian. (FONTAINE, 1961).

Subgenus ***Thomasiphyllum*** nov.

Type species: *Iranophyllum spongifolium* SMITH, 1941
Diagnosis: Solitary waagenophyllids with vesicular septa.
Remarks: SMITH (1940) found and described peculiarly constructed septa in a species of " *Iranophyllum* " and called them " naotic " with reference to the similar

structure in Silurian " *Naos* ". We tentatively call it " vesicular ", because there is a broad space with dot like projections between two plates which are in reality septal splitting in the periphery. The structure is not exactly the same with that in " *Naos* ", in which septa are represented by numerous dots on lonsdaleoid dissepiments.

DOUGLAS (1950) subsequently studied the same sort of structure in his " *Iranophyllum* " *reticulatum* and others. We are regarding them to consist of a species group which branches from the same ancestral stock with *Iranophyllum* s. str.

Pavastehphyllum* (*Thomasiphyllum*) *spongifolium (SMITH)

1941 *Iranophyllum spongifolium* SMITH, p. 6, pl. 1, figs. 10–13.
Holotype: G.B.I. Type No. 17249.
Type locality: 1.2 mile south of Pon, Southearn Shan states, Burma.

Geological age: Lower to Middle Permian. Unfortunately No. additional precise datum is available.

Pavastehphyllum* (*Thomasiphyllum*) *arachnoides (DOUGLAS)

1930 ? *Chonaxis* cfr. *pongouaensis*, REED, p. 5–6, pl. 4, figs. 4, 4a.
1950 *Iranophyllum arachnoides* DOUGLAS, p. 18, pl. 3, figs. 4, 4a.
1950 *Iranophyllum carcinophyllodes*, DOUGLAS, p. 18, pl. 3, fig. 3.
Non *Iranophyllum carcinophylloides*, DOUGLAS, 1936, p. 19–20.
Holotype: A.I.O.C. 122.
Type locality: Kuh-i-Gahkum, Province of Laristan, Iran.
Geological age: The horizon of this species is 1,200 feet below the base of Dolomite. The fossil was associated with " *Stylidophyllum* " *kueichowense* HUANG, and " *Waagenophyllum* " *chitralicum* SMITH. " *Pseudoschwagerina* " cf. *vulgaris* was said to occur 800 feet from the summit of Kuh-i-Gahkum. Judging from fossils above mentioned, together with other fossil records from horizons higher or below, the age of the present species may be considered to be *Pseudoschwagerina* zone which roughly corresponds to the upper Chuanshan limestone in South China.

REED's specimens were believed to have been found in association with " *Schwagerina* " *princeps* EHRENB. at his locality (K. 21.523) E. Shendza Dzong, Tibet, hence the age of this coral may range as low as the *Pseudoschwagerina* stage as stated above.

Remarks: The present species resembles the preceding species to some extent, but the latter is provided with a densely constructed, almost solid axial column.

The specimen described by DOUGLAS as *Iranophyllum carcinophylloides* in 1950 is not close to *I. carcinophylloides* DOUGLAS, 1936 in having vesicular septa

as was clearly described by DOUGLAS. The form really stands much closer to *arachnoides* instead of *carcinophylloides*.

REED's *Chonaxis* cfr. *pongouaensis*, from the Permian of Tibet, is also closely akin to *arachnoides*, and is probably identical with it.

Pavastehphyllum* (*Thomasiphyllum*) *reticulatum (DOUGLAS)

1950 *Iranophyllum reticulatum* DOUGLAS, p. 19, pl. 3, figs. 1, 2 and text-figs. 1a–1d.
Holotype: A.I.O.C. 124.
Type locality: 1.000 feet below the base of Dolomite, Kuh-i-Gahkum, Province of Laristan, Iran.
Geological age: Lower Permian (*Pseudoschwagerina* zone). See the preceding species.

Pavastehphyllum* (*Thomasiphyllum*) *nantanense (YÜ)

1934 *Sinophyllum*? *nantanensias* YÜ, p. 10, figs. 4, 5.
Holotype: Ser. No. Z. 21. 1 : 1.
Type locality: 7 li northwest of Kuang-shan, Nan-Tan-hsien, Kwangsi, China.
Geological horizon: Maping limestone, Lower Permian (*Pseudoshwagerina* zone)

Remarks: YÜ described a large coral from the Maping limestone of Kwangsi, for which he doubtfully employed *Sinophyllum*. However, his illustration clearly indicated the presence of axial column instead of solid columella of *Sinophyllum*, and the vesicular nature of major septa. The species belong to "*Iranophyllum*" *spongifolium* group, and the subgenus *Thomasiphyllum* is available for them.

Subgenus ***Pseudocarniaphyllum*** WU, 1962

Type species: *Pseudocarniaphyllum orientale* WU, p. 336, pl. 1, figs. 1–5, 1962

Diagnosis: Solitary Waagenophyllidae without three or more orders of septa. Lonsdaleoid dissepiments well developed.
Geological distribution: *Pseudoschwagerina* zone. Maping limestone.
Geographic distribution: Kwangsi, South China.
Remarks: *Pseudocarniaphyllum* established by WU in 1962 based on *Pseudocarniaphyllum orientale* WU as a genotype apparently resembles *Carniaphyllum* as WU believed, but the former can be viewed to be generically more closely allied to the genus *Pavastehphyllum* since it shows waagenophyllid nature in the elongate dissepiments besides normal globose dissepiments and also definite clinotabulae, besides inclined transverse tabulae. The genus *Pseudocarniaphyllum* has only

two orders of septa and lacks in a more higher order of them, and it can accordingly be allied to *Pavastehphyllum* (s. str.). The remarkable difference between them may be however the more progressive nature of lonsdaleoid dissepiments in the genus *Pseudocarniaphyllum*. Thus, we believe, WU's genus would be best placed under *Pavastehphyllum* as a subgenus.

Pavastehphyllum* (*Pseudocarniaphyllum*) *orientale (WU)

1962 *Pseudocarniaphyllum orientale* WU, p. 336, pl. 1, figs. 1–5.
Holotype: Cat. Nos. 13760–13764.
Type locality: Maping limestone at 5–6 Km. South of Desheng in the Yishan district, Northern Kwangsi.
Geological age: Lower Permian.

Pavastehphyllum* (*Pseudocarniaphyllum*) *convexum (WU)

1962 *Pseudocarniaphyllum? convexum* WU, p. 336, pl. 1, figs. 6–7.
Holotype: Cat. Nos. 13765, 13766.
Type locality and geological age: Same as the preceding species

Remarks: It may be somewhat doubtful whether the present form can be specifically distinct from the preceding species. We wish however to follow WU's opinion that the present form differs from the latter in possessing slightly thicker septa than the preceding, while the former apparently lacks in the median plate in the axial column. According to WU, the genotype of his new genus has well developed median plate.

Note: Besides the species cited above, there have been known some *Pavastehphyllum* among literatures.

Dibunophyllum sp. of HUANG (1932) probably belongs to *Pavastehphyllum*, but we must await the final identification when the longitudinal characters of this form are fully studied.

CHI described "*Carcinophyllum*" sp. and *Amygdalophyllum* sp. from Yunnan in 1938. These two forms also appear to be members of *Pavastehphyllum*, but details cannot be studied owing to the fragmentary nature of the specimens and the lack of longitudinal sections of both forms.

Further, two corals called by CHI under the name of *Dibunophyllum yuei* is noteworthy. This form was also described by him from the middle Carboniferous in Southern China. It has lonsdaleoid dissepiments and provides a fairly wide tabularium occupied by subhorizontal or slightly inclined

tabulae towards the axial part of corallite. In addition, this coral bears smaller sized elongate dissepiments at the inner side of dissepimentarium, although quite incipient in development. It can be accordingly not placed into the genus *Dibunophyllum*, but seem to be rather closer to the genus *Pavastehphyllum*.

General mode of corallites, especially the nature of septa and the presence of wide tabularium in these corals remind us however, of the Carboniferous dibunophylloid corals, and it cannot be viewed as yet to be true member of waagenophyllids.

Certainly it may need to have their own genus being independent from *Pavastehphyllum*.

(II. Fasciculate forms)

Genus ***Huangia*** YABE, 1950

1950 *Huangia*, YABE, p. 76.
Type species: *Corwenia chütsingensis* CHI, 1931.

Generic diagnosis: Fasciculate Waagenophyllidae with lonsdaleoid dissepiments. Elongate dissepiments only weakly or poorly developed. Axial column occupies, in general, a rather narrow space, being not well differentiated from the inner ends of major septa. Tabularium with horizontal tabulae is fairly wide for a member of waagenophyllid. Minor septa are lacking or are very rudimentary, if any, except for crestal septa.

Geologic distribution: Moscovian, Weiningian of China. *Fusulina* and *Fusulinella* zone.
Geographic distribution: China.
Included species: Type species only.

Remarks: The Chinese "*Corwenia*" described by CHI (1931, 1935), YOH and HUANG (1932) and HUANG (1932), including the type species in possessing elongate dissepiments, besides lonsdaleoid and probably globose dissepiments can be accordingly safely assigned into Waagenophyllidae. Needless to say, the typical *Corwenia* lacks elongate dissepiments and it must be placed into another family than Waagenophyllidae, putting aside the question for a while as to how the tabulae incline in general.

The next problem is however, how to define the limit of the genus *Huangia*, because this genus originally embraced so many differnt types of species and it has been accordingly variously interpreted by many palaeontologists.

The matter has become now quite manifest because most species having been once placed into the single genus *Huangia* by YABE would be better eliminated

from it and placed into different genera from our recent reexamination, although the senior author once fully followed YABE.

Corwenia parachihsiaensis HUANG for instance should be placed into *Akagopnyllum* nov.

Corwenia hasimotoi NAGAO et MINATO is now also concluded to be a member of *Durhamina* WILSON et LANGENHEIM 1962, althougn this was once placed by YABE into *Huangia* which was followed by the senior author, too in 1955.
Corwenia hasimotoi has a very variable axial structure, somewnat aulophylloid with a quite different number of irregularly curved septal lamellae and axial tabellae in cross section, in which the median plate is usually unobservable except in rare cases. Septa are slightly thick in the tabularium, and thin toward both ends. Dissepiments are also variable, concentric, herringbone or also londaleoid. Further, besides tabellae and tabulae, mostly flat or slightly arching towards the axis of corallite, there are tabellae inclining inwards and downwards at the outer marginal area of tabularium. All such characteristics are well observable in the genus *Durhamina* 1962, which may be very near to the genus *Orygmophyllum* FOMITCHEV. Except for almost entirely lacking of lonsdaleoid dissepiments and less developed axial structure even in the full grown stage in *Orygmophyllum*, the genus *Durhamina* is almost indistinguishable from the former.

Yet, the genus *Orygmophyllum*, *O. convexum* FOMITCHEV as the type species is now believed to embrace only solitary forms instead of fasciculate corals. Hence difference between two genera may be rather great.

Corwenia chiuyaoshanensis HUANG, and *C. lipoensis* HUANG should be grouped under the new genus *Pseudohuangia*. Also *Corwenia chihsiaensis* HUANG and *C. diphyphylloideum* HUANG must be assigned into the new genus *Chihsiaphyllum*.

Thus, the genus *Huangia* must be restricted only to the type species, at least at the present moment.

Meanwhile, this species was unfortunately not very well described and illustrated. While fully admitting the view held by CHI that the paratype specimens given by CHI are entirely conspecific with the holotype, the following discussion will be given.

First of all, the present genus seems to be perhaps fasciculate in form and much resembles *Liangshanophyllum* in general habit of corallum. However, the former provides lonsdaleoid dissepiments better developed than *Liangshanophyllum*, in which such dissepiments are almost lacking or only poorly develop, if any. IGO (1961) seems to be of the opinion that *Huangia* is entirely synonymous with *Liangshanophyllum*. Hence, he concluded that the generic name *Huangia* was already occuppied by the name *Liangshanophyllum*. He is however by no means correct.

Compared with *Akagophyllum*, the type species of *Huangia* is clearly different, in its degree of development of minor septa and elongate dissepiments.

In fact, we can recognize the presence of elongate dissepiments in CHI's species by observing the illustrated figure (especially in the corallite at the left upper corner of his fig. 3b), yet their development seems to be far less than *Akagophyllum* in general.

Further, in *Huangia*, minor septa are lacking or quite rudimentary as stated before. The minor septa-like structure observable in the paratype specimen marked in fig. 2 in plate 3 are in reality nothing but crestal septa, instead of minor ones. On the contrary, minor septa are generally in good state of development in *Akagophyllum*.

Huangia chuetsingensis (CHI)

1931 *Corwenia chütsingensis* CHI, p. 37, pl. 4, figs. 4a, b.
Holotype: Geol. Survey of China, No. 3998, 1–b.
Type locality: Tungshan, Chütsinghsien, Yuunnan, China.
Geological horizon: Weiningian white limestone.
Geographic distribution: Paratype (erroneously referred to *Corwenia* cfr. *chütsingensis*) is also known from the Laokanchai limestone, north of Piaochai, Lipohsien, Kueichow, China.

Genus ***Akagophyllum*** nov.

Type species: *Lonsdaleia* (*Waagenophyllum*) *indica* var. *akagoensis* OZAWA, 1952.

Generic diagnosis: Fasciculate Waagenophyllidae with lonsdaleoid dissepiments and tabularium with relatively broad sub-horizontal transverse tabulae. Elongate dissepiments and clinotabulae are fairly well developed, although not numerous. Minor septa are long.
Geologic range: Mostly *Pseudofusulina* to *Parafusulina* zone, but certain species may range up to the Middle Permian(?)

The following species can be placed in this genus:

Akagophyllum akagoense (OZAWA)
Akagophyllum yabei, nov.
Akagophyllum hasegawai, nov.
Akagophyllum parachihsiaense (HUANG)
Akagophyllum sp. DOUGLAS
Akagophyllum tibeticum (REED)
Akagophyllum nogamie (YAMAGIWA)

Remarks: On the occasion when the senior author once redescribed the type species of the present genus in 1955, based on the original material of the late Dr. Y. OZAWA, he mentioned that this coral should be treated as a quite independent form from any other known species of *Waagenophyllum*. And later investigation revealed that this idea can be fully accepted through various points newly recognized. Further, there are at least six species which are entirely congeneric with each other, besides the type species. Thus, this group of corals is generically quite distinct from *Waagenophyllum*.

The newly proposed genus *Akagophyllum* seems to be more nearly allied to *Huangia* YABE than *Waagenophyllum* HAYASAKA, in having relatively broader tabularium and well developed lonsdaleoid dissepiments. In addition, the area occupied by the axial column in the new genus is as narrow as in *Huangia*, being less than one fourth the length of calicular diameter.

The minor septa of the present genus, however, are much longer than the rudimentary ones in *Huangia*. Further, elongate dissepiments of the present genus seem to be slightly more progressive than in *Huangia* in size and number, even though their development is not comparable to that of *Waagenophyllum*.

The budding is also noteworthy in certain forms of the present genus. Namely, the walls are, for example, partly to develop during the earliest stage beween the hystero- and proto- corallites. Therefore, in such a form as *Akagophyllum hasegawai*, for instance, the neighbouring corallites unite with each other at least with one side of walls, and they show an arrangement of corallites which appear to be chain coral. As a result, their longitudinal section sometimes appears as if it is cerioid in form.

Akagophyllum akagoense (OZAWA)

Pl. 2, figs. 1–4; Text—figs. 27–31, 48 ag.

1923 *Lonsdaleia kotoana* OZAWA (MS), p. 243, listed only.
1925 *Lonsdaleia* (*Waagenophyllum*) *indica* var. *akagoensis* OZAWA, p. 76, p. 33, fig. 1. 14, figs. 7–9.
1955 *Waagenophyllum akagoensis*, MINATO, p. 107, p. 30, fig. 4: non pl. 33, fig. 1.
1961 *Huangia akagoensis*, YAMAGIWA, p. 97, pl. 6, figs. 1, 2.
Specific diagnosis: *Akagophyllum* with relatively thin septa and wall.

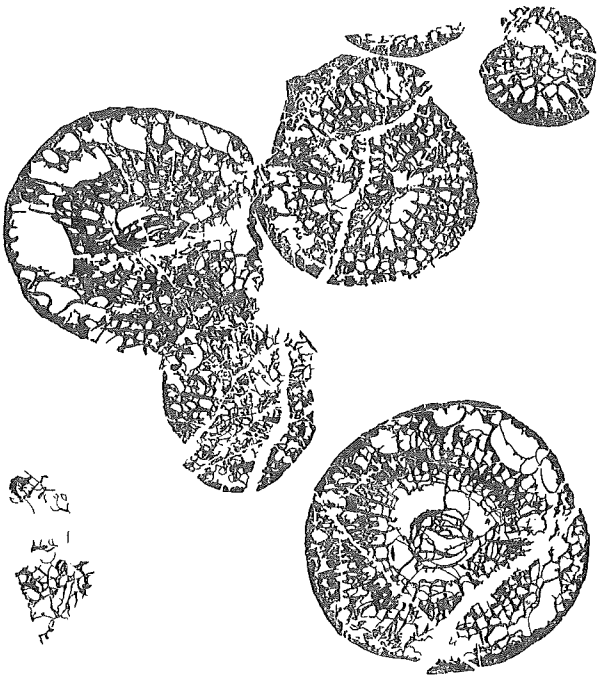
Description: Former description given by the senior author must be slightly modified based on numerous materials newly collected. Corallum fasciculate, phaceloid; corallite irregularly aggregated in space, occasionally close in contact, while sometimes very widely spaced with each other. Wall rather thin.

In the neanic stage, when the calicular diameter is less than 5 mm in length, the axial structure is very simply constructed and occupies a very narrow space,

the diameter being less than 1.0 mm. In this stage, major septa are less numerous and 17 may be the maximum. Minor septa are very short, and show so-called " Keilsepten " type at this stage, if any. Further, there are no lonsdaleoid dissepiments. Septa, both major and minor, are generally thin except at their base.

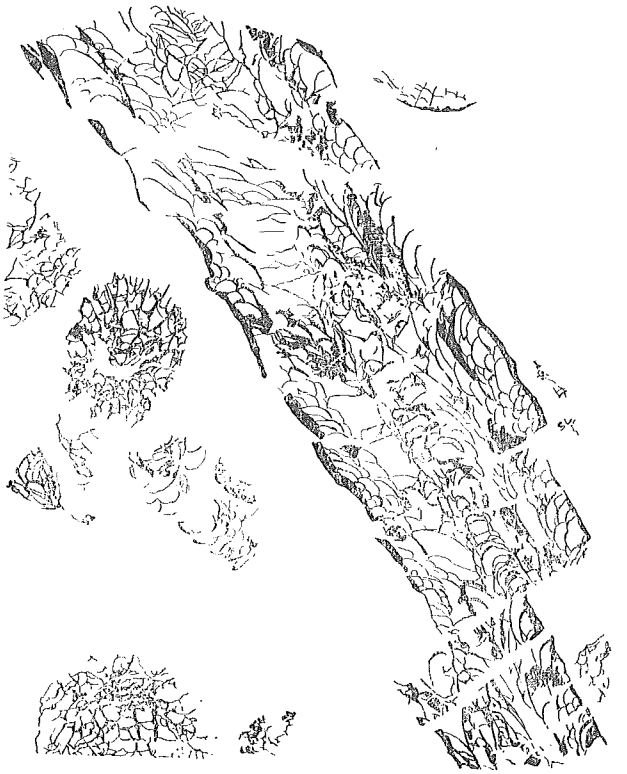
In the ephebic stage, corallites become larger, the calicular diameter being 7 to 11 mm in general, though it attains as much as 12 mm in maximum length. In this stage, lonsdaleoid dissepiments appear, and the axial structure becomes exceedingly complex, occupying a little broader area than before. Major septa also become numerous, ranging from 20 to 28 in number, which alternate with the same number of minor spta. The minor septa also become longer immediately after the neanic stage.

In the cross section of septa, there is a translucent layer at the central portion of septa; on both sides of this layer, there is a narrow black zone. Fibres are subperpendicular to the said black zone, although some sort of bundling is still discernible. Thus the septa of this species represent the diffuso-trabecular type of KATO (1963).



Text-figure 27

Akagophyllum akagoense (OZAWA) (×3.4)
Kaerimizu, Akiyoshi-dai, Yamaguchi Prefecture. *Pseudofusulina* zone. UHR 18145 a.

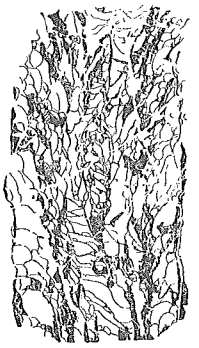


Text-figure 28

Akagophyllum akagoense (OZAWA) (×3.8)
Kaerimizu, Akiyoshi-dai, Yamaguchi Prefecture. *Pseudofusulina* zone. UHR 18146 b.

TEXT-figure 29

Akagophyllum akagoense (OZAWA) (×3.5) Kaerimizu, Akiyoshi-dai, Yamaguchi Prefecture. *Pseudofusulina* zone. UHR 18157



T ext-figure 30

Akagophyllum akagoense (OZAWA) (×2.4) Kaerimizu, Akiyoshi-dai, Yamaguchi Prefecture. *Pseudofusulina* zone. UHR 18145 d.

Text-figure 31

Akagophyllum akagoense (OZAWA) (×3.0) Kaerimizu, Akiyoshi-dai, Yamaguchi Prefecture. *Pseudofusulina* zone. UHR 18159.

diameter	septal number	without lonsdaleoid dissepment	with lonsdaleoid dissepment
3 mm	24	—	
4 mm	34	—	
4.5 mm	32	—	
4.7 mm	32	—	
5.0 mm	32	—	
7.0 mm	40		—
8.0 mm	42		—
9.0 mm	44		—
9.5 mm	46		—
11.0 mm	52		—

The axial structure is in general irregularly and loosely constructed, in which septal lamellae are less numerous than the axial tabellae and median plate is not always well observable, if not completely lacking. Further, the median plate, if it is observed, is not straight in the cross section, but somewhat curved or sinuous.

The counter septum is a little longer than the cardinal one; the former is occasionally united with the axial structure, not only in the neanic but also in the ephebic stage. Nevertheless, the counter septum rarely unites with the median plate but rather with the axial tabellae. Lonsdaleoid dissepiments are sometimes very large and quite distinct from the interseptal globose dissepiments in their form and arrangement, both in cross and longitudinal sections.

In the longitudinal section, the dissepimentarium is rather narrow. In the outer zone of which, unequal sized lonsdaleoid dissepiments are distinguishable from the small but equal sized globose dissepiments, while in the inner zone, fairly large sized elongate dissepiments are arranged in one or two rows.

The clinotabulae are large and steeply inclined in general, while the transverse tabulae generally gently incline towards the axis of the corallites and are rather sporadical in their distribution. The median plate is indistinct.

Type specimens of the present species: There are 7 thin sections of the present coral, now stored at the Geol. Inst. Tokyo Univ.; with labels numbered 77, 78, 79, 80, 81, 83, and 84, in which the name of *Lonsdaleia kotoi*, n. sp. was given in OZAWA's hand writing; in addition, the name of type locality can be read as: Kaerimizu, Akago-mura, Mine-gun, Yamaguchi Prefecture.

No doubt, all these 7 slides were made from coral samples belonging to a single species, although it is not certain, whether all the sections were actually made from a single corallum. Of the seven slides, three sections numbered 80, 79 and 83 were illustrated by OZAWA in his plate 14, as figs. 7, 8 and 9 respectively.

Dr. Y. HASEGAWA, also lately collected two corals (HASEGAWA's coll. nos. 193 and 138) belonging to the same species at Kaerimizu, which were sectioned by the junior author and reported in the present paper. The reg. nos. of the slides are UHR 18145 a, b, c, d and 18146 a, b, respectively. According to HASEGAWA, these corals were found at the northern slope of the so-called Kaerimizu valley, at a point, some 220 m above sea level.

Remarks: Although the true outer form of the present coral is unknown to us, the neighbouring corallites are sometimes observed to be partly joined to each other with a common wall; this feature may be quite worthy of note, as stated in the remarks of the genus. (See text-fig. 48)

Geological horizon: *Pseudofusulina* zone. See the part of the stratigraphy in regard to the associated fossils.

Specimens in our repository, Reg. nos. UHR 18145 (a-d), 18146 (a, b), 18155–18161, Kaerimizu, (HASEGAWA's coll. nos. 193 and 138), Akiyoshi Plateau, Yamaguchi Prefecture.

Akagophyllum yabei, sp. nov.

Text—fig. 32

1955 *Waagenophyllum akagoensis*, MINATO, p.l 33, fig. 1
Non *Waagenophyllum indicum akagoensis* OZAWA, 1925, p. 76.

Diagnosis: *Akagophyllum* with thickly constructed corallites in which septa, axial structure, dissepiments and walls are all very thick.

Text-figure 32

Akagophyllum yabei MINATO et KATO, sp. nov. (×3.2)
Kaerimizu, Akiyoshi-dai, Yamaguchi Prefecture. *Pseudofusulina* zone. No. 7923, IGPS.

Holotype: Single thin section, now stored at the Inst. Geol. and Palaeont. Tohoku Univ., in Sendai, 7923. On the label attached to the thin section, the name of *WaagenopIyllum kotoana* OZAWA can be read, which is now assumed to have been written by Prof. YABE. The name *kotoana* is the manuscript name, once given by OZAWA to his *Waagenophyllum indicum* var. *akagoensis*.
Type locality: Same as the preceding species.
Remarks: Although the illustration for the present form, illustrated as fig. 1 on plate 33 in the former paper of the present senior author in 1955 did dot well show the skeletal structures in detail, one cannot recognize any marked difference between the type species and the present form, with regard to the construction of the skeletal elements.

In fact all of the skeletal units of the present form are, however, very thickly constructed, as may be seen in text-fig. 32.

In the neanic stage, the present form does not show any marked difference from the type species of the genus *Akagophyllum*, but the distinction between them becomes manifest in the ephebic stage, especially in the thickness of all skeletal elements. Further, in the present form, lonsdaleoid dissepiments seem to be far less developed than the preceding species.
Reg. no. UHR 18153, 18154: Holotype; Reg. no. 7923 Geol. Palaeont. Inst., Tohoku Univ., Sendai

Akagophyllum hasegawai, sp. nov.

Pl. 3, fig. 1; Text—figs. 33, 34 & 48 h.

Holotype: Reg. no. UHR 18147 a, b

Specific diagnosis: Aberrant form of *Akagophyllum*. Corallum apparently phaceloid, but the neighbouring corallites are partly united by their walls and are arranged in a form resembling chain coral.
Description of thin sections: Corallum fasciculate and nearly phaceloid, but corallites mostly in contact with each other with a rather straight common wall in the cross section. Accordingly corallites are not round but irregularly polygonal at least at the part united with the neighbouring ones.

Wall rather thin. Axial column is small, loosely constructed in general by septal lamellae and tabellae. Median plate is present, but generally not straight. Septa in two orders; both major and minor ones are thin and fairly long; the major ones nearly reach the axial column but do not directly unite it, while the minor ones are a little shorter than the former; the minor ones are in general 4/5 the length of the former.

In the neanic stage, the axial column is almost lacking or is constructed by

irregularly curved few lamellae. Further, there are no lonsdaleoid dissepiments at this stage.

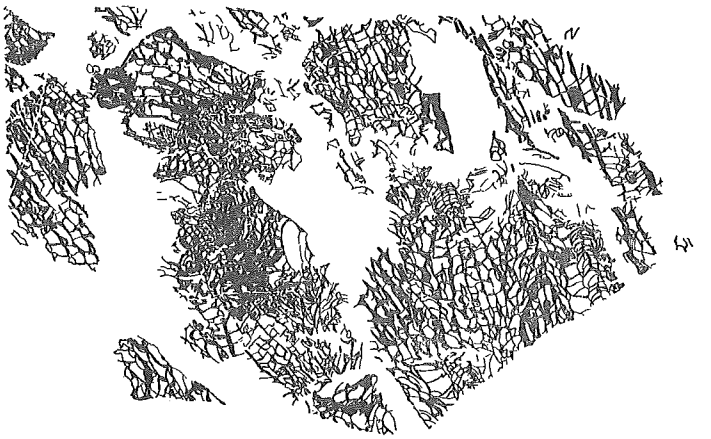
Dissepimentarium is rather narrow, where rather small lonsdaleoid dissepiments develop, besides somewhat concentrically arranged globose dissepiments in a few rows are seen.

Calicular diameter	septal number	lonsdaleoid dissepiments
1.5 to 2.0 mm	9+ 8	none
3.0 to 3.1	12+12	none
4.0 to 4.0	15+15	present
4.0 to 5.0	15+15	present
4.5 to 5.0	15+15	present
5.0 to 5.0	16+16	present
4.0 to 6.0	17+17	present

In the longitudinal section, the axial column occupies a rather narrow space, but is well difined from other parts, composed of closely set, upward arching tabellae, discontinuous median lamella, and a few septal lamellae. Transverse tabulae are rather wide, sporadic in distribution, gently inclined in general to-

Text-figure 33

Akagophyllum hasegawai MINATO et KATO, sp. nov. (×3.8); Behind Hinaga shrine, Mine city, Yamaguchi Prefecture. *Pseudofusulina* zone??. UHR 18147 a.



Text-figure 34

Akagophyllum hasegawai MINATO et KATO, sp. nov. (×3.4) Behind Hinaga shrine, Mine city, Yamaguchi Prefecture. *Pseudofusulina* zone?? UHR 18147 b.

wards the axis of corallite. Elongate dissepiments are small in size, but their presence is doubtless. Clinotabulae locally develop, which are rather small and do not highly incline.

Septal structure is the same as the type species of the genus *Akagophyllum*.

Remarks: The present species is quite distinct from other species of the genus *Akagophyllum* in their growth habit. The arrangement of corallites remind us of the aberrant form of *Siphonodendron* named by KATO as *Siphonodendron hidense* which was illustrated by us in a previous paper (1959). In the latter the corallum is composed of corallites united with each other by common walls, nearly straight in the cross section.

The present form may be viewed to be rather closer to the type species of the genus *Akagophyllum* than the preceding species only in having corallites constructed by thinner skeletal elements. However in the degree of development of lonsdaleoid dissepiments, the present form may be akin to the preceding species. Yet from both species, the present coral is specifically distinct from the characteristic growth habit stated above.

Type locality: Behind the Hinaga Shrine, not far from Shibukura, Mine city, Yamaguchi prefecture.

Reg. nos. UHR 18147a, 18147b, Holotype.

Geological horizon: The specimen was collected by the junior author from the *Yabeina* limestone cropped out at the locality described above, so that the geological horizon of this coral may be the *Yabeina* zone. However, the limestone in which this coral was found is very brecciated and conglomeratic. There seems

accordingly to be some possibility remaining that the coral now in question may be a derived fossil from certain lower formations, the *Pseudofusulina* limestone for instance.

As a species belonging to the genus *Akagophyllum*, the present coral is rather unique in arrangement of corallites. Therefore it may be also possible to really denote the *Yabeina* zone, as a most specialized form among the genus *Akagophyllum*. In any event the exact geological horizon of this coral cannot be described with certainty at the present moment.

Akagophyllum parachihsiaense (HUANG)

1932 *Corwenia parachihsiaensis* HUANG, p. 51, pl. 2, figs. 18, 19.
Non *Heritschia parachihsiaensis*, FLÜGEL, 1955, p. 308, p. 35, fig. 12.
Geological horizon and localities: Chihsia limestone between Wengch'eng ch'iao and Tsyngpachieh, Kueitinghsien, Kueichow, V.K. TING's collection (Loc. no. T. 103 K). Paratype specimen of the West-Lake Museum were collected by S.F. SHENG at Hangchow from Chiuyaoshan, Hangchaow, Chekiang. The formation is now believed to be the Feilaifeng limestone of the Lower Permian.

Remarks: Although the exact nature of the longitudinal section in this coral is unknown to us, we tentatively place it in the genus *Akagophyllum*, based on its possessing lonsdaleoid dissepiments.

HUANG once described the presence of the tertiary septa in this coral. However, it may be a mistake. So far as the illustrations given by him are concerned, there seem to be no more than incipient and shorter minor septa developing between the major septa.

Akagophyllum sp.

1936 *Lonsdaieia* sp., DOUGLAS: p. 14, pl. 1, fig. 8.

Remarks: DOUGLAS accurately described this fasciculate coral as having septa reaching in general not the epitheca and may be accordingly viewed to have lonsdaleoid dissepiments. However, DOUGLAS neither illustrated the longitudinal section nor described the nature of it. Therefore, there is a slight doubt left in assigning this coral into the present genus. From the general construction of corallite, we believe now, however, that this coral should be better transferred from *Lonsdaleia* and placed into the genus *Akagophyllum*.

Locality: Darreh, Duzdun, Iran.
Horizon: Not certainly known. But the following fossils were found in association with this coral: *Michelinia siyangensis* REED, *Stylidophyllum jenningsi* DOUGLAS, *Wentzelella*

subtimorica HUANG, *Waagenophyllum* aff. *omiensis* YABE et HAYASAKA and *Linoproductus lineatus* (WAAGEN). Of these, the first one can be regarded as an element of *Pseudofusulina* zone, and the second one is *Wentzelophyllum*, the Lower Permian genus, ranging from the *Pseudoschwagerina* to the *Pseudofusulina* zone. Hence, the authors wish to tentatively estimate the stratigraphical horizon of this coral to be the *Pseudofusulina* zone.

Akagophyllum tibeticum (REED)

1930 *Lonsdaleia tibeticum* REED, p. 11, pl. 4, figs. 2, 2a.

Diagnosis: *Akagophyllum* with numerous thick septa, thin wall and weakly developed lonsdaleoid dissepiments.

Type locality: N. side of Ngantse Tsi, Tibet (K. 21. 525)
Horizon: REED stated that this species was found in association with *Syringopora catenoides* REED and *Chonaxis* cf. *pongouanensis* MANSUY. The second named species, however is not conspecific with MANSUY's species but may be referable to *Pavastehphyllum* (*Thomasi.*) *arachnoides* (DOUGLAS).

In any event, the so-called *Chonaxis* cf. *pongouanensis* of REED was said to have been also found at two other localities above mentioned. According to REED, at one locality, east of Shendza Dzong, K. 21.523, it was collected in association with "*Schwagerina*" *princeps* EHRENB. Hence, the age may be the *Pseudoschwagerina* zone.

Remarks: The present form can be viewed to be rather closely allied to *Akagophyllum yabei* newly proposed, both in having thick septa and in possessing less developed lonsdaleoid dissepiments.

REED described that all the septa reach the epitheca, near which they thickened, but with no sharply defined peripheral dissepimental zone. But the presence of lonsdaleoid dissepiments in this species is doubtless through observation of the illustrated corallites in cross section.

In any event, the Tibetian species is, however, distinct from *Akagophyllum yabei* in having a far larger number of septa, which are also slightly thinner than that of the Japanese species, especially in the dissepimentarium.

Putting aside the present species now in question for a while, it may be also worthy of note that REED once mentioned the occurrence of *Lonsdaleia* cf. *indicum akagoensis* OZAWA from Tibet. According to him, the mentioned coral was stated to have been found at his locality (K. 21. 527) Mar-Kung, on the N. side of Ngantse Tso. However, he did not give any detailed description for that coral and the true nature of it is at present unknown to us.

Akagophyllum nogamie (YAMAGIWA)

1961 *Waagenophyllum nogamie* YAMAGIWA, p. 94, pl. 7, figs. 1, 2, 3.
Holotype: Reg. nos. 60048, 60049, 60050, thin sections.
Type locality: Locality no. 23, Atetsu plateau.
Horizon: *Pseudofusulina* zone? or *Parafusulina* zone?

Remarks. The specimens described by YAMAGIWA (1961) from the Permian of Atetsu in southwest Japan under the name of *Waagenophyllum nogamie* seem to us to be another species belonging to the genus *Akagophyllum*. In his specimens, the septa are very thick and are nearly entirely joined with each other in the peripheral area as in *Akagophyllum yabei;* yet most septa of the corals described by YAMAGIWA become abruptly thin inward and locally discontinuos where lonsdaleoid dissepiments begin to develop, although YAMAGIWA paid little attention in this regard. Such feature seems to be rather common with our species *yabei* newly proposed.

However, in the YAMAGIWA's specimens, septa are not always straight but irregularly change in direction of growth, giving an appearance of having a carinae like process in the cross section.

Such septal structure is also by no means seldom found in waagenophyllid corals, yet it may be a good criterion to specifically distinguish YAMAGIWA's specimens from our species *yabei*.

Further, the axial structure of YAMAGIWA's species is more finely constructed by less thick lamellae and tabellae than our species *yabei*, although the outermost tabellae are somewhat thickened even in the YAMAGIWA's species, as was described by him.

YAMAGIWA reported the presence of tertiary septa in his specimens. If it is true, his specimens may neither belong to *Waagenophyllum* nor *Akagophyllum*. However, there are no such higher orders of septa in his species, so far as the specimens given by him are concerned.

Fortunately, his illustration is sufficient for a minute examination in this regard. One of the corallites given by YAMAGIWA in figure 1 of plate 7 is very obliquely cut, so that certain septa may appear to be shorter than others. Further, certain interspace between septa is so narrow, as a result of septal thickening, that it may be misunderstood to be tertiary septa. Except for these two cases, there is no indication to assume the presence of tertiary septa in this species. In any event, the presence of tertiary septa in the YAMAGIWA's species is thus highly questionable and almost improbable.

Also, the horizon of this coral is not finally settled in our opinion. YAMAGIWA reported in his paper that the coral was found from a limestone representing the

Neoschwagerina zone. It may be not absolutely deniable. However, there seems to remain much ambiguity in his description regarding the stratigraphical account of this coral now in question. In addition to this, almost all other species belonging to the genus *Akagophyllum*, except for *A. hasegawai* are only known from the Lower Permian formation. We are now accordingly a little suspicious to conclude the stratigraphical position of this coral as the *Neoschwagerina* zone.

Finally, the specific name of this coral may also be a problem, though not important. YAMAGIWA proposed the name *nogamie* to his coral, which, we assume, was dedicated to Dr. NOGAMI who has been working in the field of Atetsu limestone plateau. If so, the specific name should be spelled *nogamii*, instead of *nogamie*. Now supposing YAMAGIWA gave the specific name to the coral in dedication to Mrs. NOGAMI instead, it should be spelled as *nogamiae*. Here we are obliged, though against our will, to follow his miss-spelling by the rule of nomenclature.

Genus ***Heritschiella*** MOORE et JEFFORDS, 1956

1931 *Heritschia* MOORE and JEFFORDS, p. 94, (Non TEPPNER, 1922)
1944 *Heritschia*, SCHROCK and SHIMER, p. 87
1956 *Heritschiella*, MOORE and JEFFORDS in HILL, F. 310
Type species: *Heritschia girtyi* MOORE et JEFFORDS, 1941

Generic diagnosis: Fasciculate Waagenophyllidae with compact and narrow axial column, and with broad dissepimentarium. Tertiary septa absent. Transverse tabulae nearly horizontal or concave upwards, which locally occupy the entire tabularium. Yet, clinotabulae develop with certainty. Large and small elongate dissepiments are also present. Without lonsdaleoid dissepiments.
Geologic and geographic distribution: Wolfcampian, *Pseudoschwagerina* zone of North America (Kansas).
Included species: *Heritschiella girtyi* (MOORE et JEFFORDS), 1941 only.
Remarks: HILL defined the genus to have tertiary septa, however, we do not think that this is the case in *Heritschiella*. What appeared to be tertiary septa are nothing but short, newly inserted septa which do not reach the mature stage.

MOORE and JEFFORDS included many Chinese, Iranian, Japanese and other "*Corwenia*" corals into their genus. Among them, however, there is a form such as *Waagenophyllum columbicum* SMITH, which has a different kind of tabulae from those in waagenophyllids. And we think it correct that YABE once separated this form from the others as belonging to a new genus *Heritschioides*. As to the other waagenophyllids once considered to belong to *Heritschiella*, they are better assigned to *Pseudohuangia*. So the present genus has to be restricted to the genotype only, at the present moment.

Heritschiella apparently closely resembles *Pseudohuangia*. Among *Pseudo-*

huangia, the so-called " *Corwenia* " *lipoensis*, for instance, has a relatively small and rather compact exial column, and the feature of the corallite seems to somewhat resemble the present genus.

However, *Herischiella* has broad dissepimentarium, in which a great number of globose dissepiments and elongate dissepiments are developing. In addition, the axial column is much more compact. The present genus may be accordingly easily distinguishable from *Pseudohuangia*.

Waggenophyllum (*Liangshanophyllum*) is another ally to *Heritschiella*, but is distinguished from the latter by having smaller corallites, narrow dissepimentarium, and a somewhat moderate appearance of construction in the axial column, besides the septa are not as numerous as those in the latter.

Heritschiella girtyi (MOORE et JEFFORDS)

1941 *Heritschia girtyi* MOORE et JEFFORDS, p. 98, pl. 4, figs. 5–8, ; pl. 7 figs. 1, 2 ; pl. 8, fig. 5.
1941 *Heritschiella girtyi*, HILL, p. 310, fig. 210, 2a, 2b.
Type : no. 34191, University of Kansas.
Type locality : Upper part of Florence limestone, along a road in NE1/4SE1/4, sec. 31, T. 27S, R. 6E, about 12 miles southwest of Leon, Butler county, Kansas, U.S.A.
Geological horizon : Wolfcampian (= *Pseudoschwagerina* zone).

Genus ***Chihsiaphyllum*** nov.

Type species : *Corwenia chihsiaensis* YOH, 1932.
Distribution : Chihsia limestone of China

Included species : *Chihsiaphyllum chihsiaense* (YOH), 1932
Chihsiaphyllum diphyphylloideum (HUANG), 1932.

Diagnosis: Corallum fasciculate. Corallites cylindrical, medium to small in size. Septa are of two orders, in which minor septa are very short. The axial structure is an aulos like column with horizontal inner tabulae, in mature corallites. Dissepimentarium narrow. Outer tabulae, viz. clinotabulae incline towards the axial structure.

Remarks: In possessing aulos like axial structure, this new genus is very unique. In younger corallites the normal type of axial columns, though small in size, are present (see YOH and HUANG, 1932, pl. 8, figs. 1–2). As they grow larger, the axial structure tends to become loose and then take aulos like forms, which HUANG called " diphyphylloid ".

In spite of its possession of aulate axial structure we still consider the present

genus to be a member of Waagenophyllidae, since it has distinct clinotabulae. Further, the younger corallites are readily comparable with the other fasciculate Waagenophyllidae such as *Liangshanophyllum*.

The new genus is very easily distinguishable from the other fasciculate waagenophyllids by the presence of the aulos like axial structure and narrow dissepimentarium compared to the size of corallite.

It is also easily separable from the Lower Carboniferous fasciculate *Aulina*, since it has clinotabulae instead of having uparched tabulae in true *Aulina*.

HUANG considered forms here included in the present new genus to represent Lower Chihsian, which we regard to be equivalent to the *Pseudofusulina* zone of Lower Permian.

Phylogenetically it may be quite true to say that this new genus was derived from a primitive form of *Pseudohuangia* or a common ancestral form with the latter by the formation of aulate axial structure, since ontogenical change of axial structure in the type species suggests the course.

Chihsiaphyllum chihsiaense (YOH)

1932 *Corwenia chihsiaensis* YOH, in YOH and HUANG, p. 27, p. 8, figs. 1–3.
Holotype: Cat. no. 1175, Geol. Surv. China.
Type locality: Chihsiashan, South China.
Geological horizon: Lower Chihsia limestone.

Chihsiaphyllum diphyphylloideum (HUANG)

1932 *Corwenia diphyphylloides* HUANG, p. 54, pl. 16, figs. 1a (par), 1b, 1c.
Holotype: Cat. no. 3944, Geol. Surv. China.
Type locality: Laoshan, Hsiangchuanshahn, Hochow, Anhui, China.
Geological horizon: Lower part of Chihsia limestone.

Remarks: Although the corallite in the longitudinal section in fig. la does show a marked difference to the holotype specimen recorded by HUANG as fig. 1c on the same plate 16, the former may represent the younger stage of this coral.

In fig. la there can be seen a clear axial column composed of arched tabellae and certain lamellae, while in fig. 1c, only a tube like exial structure occupied solely by sparse, slightly concave to sub-horizontal tabulae are observable. Accordingly, the difference between those two corallites seems to be rather great.

Nevertheless, they may belong to the same species, because of a gradual change from each other in regard to the axial structure. The corallite illustrated in the right lower corner in fig. 1a certainly possesses uparched tabellae but another

corallites seem to have no such tabellae and their axial area seems to be well spaced. Yet, in certain corallites, septa are observable to extend far into the central area.

In the mean time, the corallite shown in the left upper corner in fig. 1a reveals an aulate axial structure being quite identical with the corallites figured in fig. 1b. Therefore, it may be quite probable that the changes seen in various corallites in fig. 1a are not the results from the specific difference but rather from the different stage of ontogeny. In all probability, corallite having aulos shows the mature stage, and corallites with longer septa or weakly constructed axial column represent an earlier one, as it is observed in the type species of the present genus.

We believe now that the earlier stage of the present species somewhat resembles *Pseudohuangia chiuyaoshanensis* (HUANG) and this may be important in the consideration of the phylogeny of the genus *Chihsiaphyllum*.

Genus ***Pseudohuangia*** nov.

Type species: *Waagenophyllum chitralicum* SMITH, 1935.

Generic diagnosis: Fasciculate Waagenophyllidae without lonsdaleoid dissepiments. Elongate dissepiments are mostly small in size and not numerous. Clinotabulae are also not very well developed, apparently lacking in some corallites of a certain species, and may be generally not highly inclined if they are present. On the contrary, transverse tabulae are well developed and widely spaced in general. They are nearly complete and not very much cystose. The axial column usually occupies a relatively narrow space, and gives a " clisiophyllid " appearance. Dissepimentarium is also comparatively narrow, though the inner wall formed at the inner margin of the dissepimentarium is nearly always conspicuous. Septa are more or less intrathecally dilated.

Geologic distribution: *Pseudoschwagerina* to *Yabeina* zone.
Geographic distribution: China, Viet-Nam, Pakistan, Iran and Turkey.

Remarks: The present new genus differs from *Huangia* and *Akagophyllum* mainly in its lack of lonsdaleoid dissepiments.

The new genus appears to be allied to *Waagenophyllum*, especially to its subgenus *Liangshanophyllum*, but is rather considerably different from the latter in having a gently inclined clinotabulae, " clisiophyllid " axial column, intrathecal dilation of major septa and not having any remarkable developments of elongate dissepiments.

Heritschiella also resembles *Pseudohuangia*, but is separable from the latter by its broad dissepimentarium and the presence of distinct large elongate dissepiments in the former.

Included species:

Pseudohuangia chiuyaoshanensis (HUANG)
Pseudohuangia persica (DOUGLAS)
Pseudohuangia tabellata (DOUGLAS)
Pseudohuangia chitralica (SMITH)
Pseudohuangia cincta (DOUGLAS)
Pseudohuangia minima (DOUGLAS)
Pseudohuangia lipoensis (HUANG)
Pseudohuangia counilloni (MANSUY)
Pseudohuangia tsengi (ZHAO et CHEN)
Pseudohuangia stoecklini MINATO et KATO, sp. nov.

Pseudohuangia chitralica (SMITH)

1925 *Waagenophyllum indicum*, SMITH in REED (non WAAGEN et WENTZEL), p. 14, pl. 1, figs. 24–27.
1935 *Waagenophyllum chitralicum* SMITH, p. 37, pl. 8, figs. 7, 8.
1936 *Waagenophyllum muricatum*, DOUGLAS, p. 22, pl. 1, fig. 9.
1950 *Waagenophyllum chitralicum*, DOUGLAS, p. 11, pl. 1, figs. 2, 2a, b, c.
Non *Heritchia chitralica*, FLÜGEL, 1955, p. 307, pl. 35, fig. 11.
Holotype: Geol. Surv. India, coll. slide nos. 116–9 (k. 18. 766) (by monotypy)
A part of the holotype is now stored at the British Museum of Nat. Hist. R. 27870–1.
Type locality: Right bank of Yarkun river, 2 1/2 miles north of Baroghill, Ailak, N.W. Province, Chitral, Pakistan.

Remarks: This spcies shows considerable variation in skeletal features. But the axial column usually occupies a relatively wide space, and its structure is rather densely constructed, in which the median plate is inconspicuous. The inner wall made up by the inner margin of dissepimentarium is especially remarkable in the neanic stage, becoming less conspicuous in the mature stage.

The elongate dissepiments certainly develop in the present species, most of which are, however small in size. In addition, clinotabulae develop with certainty in the tabularium, besides having rather wide transverse tabulae. The former of which are, however gently inclining in general.

DOUGLAS stated in a 1950 paper that his *muricatum* was synonymous with *chitralicum* SMITH. We tentatively wish to follow his view, although *muricatum*, in actuality has a rather simple appearance in the structure of corallite and the axial column with a distinct median plate somewhat smaller than that of *chitralicum*. Further, no longitudinal character of *muricatum* is known to us at the present.
Distribution: Chitral, Pakistan (Type locality), with *Polydiexodina* and *Parafusulina*. *Parafusulina* zone.

Tang-i-shakari and Tang-i-zaghin, Gahkum area Iran with *Michelinia* and *Polythecalis*. *Pseudofusulina* zone.
Kuh-i-Gahkum, below " *Pseudoschwagerina* " aff. *vulgaris* horizon, possibly the *Pseudoschwagerina* zone.

Pseudohuangia chiuyaoshanensis (HUANG)

1932 *Corwenia chiuyaoshanensis* HUANG, in YOH and HUANG, p. 29, pl. 8, figs. 5–6.
1932 *Corwenia chiuyaoshanensis*, HUANG, p. 53, pl. 16, figs. 2a, b.
1933 *Corwenia chiuyaoshanensis*, YOH, pl. 1, figs. 2a, b.
Holotype: Cat. no. 3942, Geol. Surv. China.
Type locality: Chiuyaoshan, Hangchow, Chekiang, China.
Geological horizon: Chihsia limestone (=Feilaifeng limestone)
Geographic distribution: Chekian, Anhui, Kueichow, and Kwangsi. All in South China.

Remarks: This species has rather less developed elongate dissepiments, although their presence is doubtless. Further, the clinotabulae are apparently lacking in most cases, although they are observable in some individuals. On the contrary, transverse tabulae are wide and nearly complete. All these nature above stated, seem to be quite common in the " *Waagenophyllum* " *chitralicum* group of corals, although it comprises a different species group together with " *Corwenia* " *lipoensis* and " *Corwenia* " sp. of YOH and HUANG. The last unnamed one may be conspecific with " *Corwenia* " *chiuyaoshanensis*. This species normally possesses no thickened inner wall and a distinct median plate in the axial column.

Pseudohuangia tabellata (DOUGLAS)

1936 *Waagenophyllum tabellatum* DOUGLAS, p. 21, pl. 1, figs. 2, 2a.
Non *Waagenophyllum tabellatum*, FLÜGEL, 1955, p. 299, pl. 33, fig. 7.
Non *Waagenophyllum* cfr. *tabellatum*, FLÜGEL, 1955, p. 299, pl. 34, fig. 5.
Holotype: Slide no. S.P.R. 3395. Specimens G.S.I. type no. 15901 and 15901a.
Type locality: Chal-i-Sheh, Iran.
Geological horizon: *Pseudofusulina* zone?

Remarks: The cross section of the present species seems to closely resemble the type species of the genus *Pseudohuangia*. However, in the longitudinal section, the clinotabulae in the present species are not as well developed as that of the type species.

Actually, the transverse tabulae nearly entirely occupy the tabularium, which are sub-horizontal in general but locally incline even towards the dissepimentarium.

Yet, the presence of a few clinotabulae in the present form cannot be denied, because its existence is clearly indicated at the upper right side of the tabularium in the corallite illustrated by DOUGLAS. Further, elongate dissepiments are also present with certainty.

From the character of the longitudinal section, the present form may be more closer to the preceding species. But the present form has a decidedly larger axial column.

Pseudohuangia lipoenis (HUANG)

1932 *Corwenia lipoensis* HUANG, p. 52, pl. 2, figs. 20–22.
Type specimen: Cat. nos. 3851–3852, Holotype. 3853, Paratype. Geol. Surv. China.
Type locality: 1 li west of Laochialiang, Lipohsien, Kueichou, China.
Geological horizon: Base of Chihsia limestone, which may belong to the *Pseudofusulina* zone in our opinion.

Remarks: Axial column of this species is relatively large in the holotype but small in paratype. Inner wall is absent. Elongate dissepiments and clinotabulae are certainly present. The species is as a whole very close to *chiuyaoshanensis*, as HUANG stated. However, the present form is specifically distinct from the latter. According to HUANG, the tabellae in the present form are represented by sloping cysts, the typical cone in cone structure showin in *C. chiuyaoshanensis* being entirely lacking.

In addition, there is no distinct inner wall in the present form, while its columella is proportionately much thicker than that in other forms.

Pseudohuangia persica (DOUGLAS)

1936 *Waagenophyllum persicum* DOUGLAS, p. 20, pl. 1, figs. 1, 1a; pl. 2, fig. 9.
1950 *Waagenophyllum persicum*, DOUGLAS, pl. 1, figs. 3, 3a, figured only.
Non *Waagenophyllum persicum*, FLÜGEL, 1955, p. 300, pl. 34, figs. 6a, b.
Holotype: G.S.I. nos. 15899, 15899a: slide no. S.P.R. 1469.
Type locality: Galleh Shah, Iran.
Geological range: The species is associated with *Polydiexodina persica* at the type locality. And in Tang-i-la it is accompanied by *Polythecalis* and *Michelinia*.

At Kuh-i-Gahkum the species is said to have come from the horizon above "*Pseudoschwagerina*" aff. *vulgaris* (DOUGLAS, p. 5–6, 1950). So, in general, the age of this species may range from *Pseudofusulina* to *Parafusulina* zone.
Geographic distribution: Galleh Shah, Tang-i-la, Galleh Siga and Kuh-i-Gakkum of Iran.

Remarks: The present species is characterized by its larger corallites and smaller sized axial column with distinct median plate as compared with the type species of the genus *Pseudohuangia*. Otherwise both of them are rather similar to each other.

Pseudohuangia cincta (DOUGLAS)

1950 *Waagenophyllum cinctum* DOUGLAS, p. 12, pl. 1, figs. 6a, b.
Holotype: A.I.O.C. 105.
Type locality: 4 mls. N.E. of Surmaq, Quashgai Sarhad, Iran.
Geological age: *Neoschwagerina craticulifera* zone (see p. 7, DOUGLAS, '50).

Remarks: This species possesses a small axial column, being only one fourth of the diameter of corallite, and somewhat long minor septa. We think this species is a descendent of *Pseudohuangia minima* (DOUGLAS).

Pseudochuangia minima (DOUGLAS)

1950 *Waagenophyllum minimum* DOUGLAS, p. 10, pl. 1, figs. 4a, b.
Holotype: A.I.O.C. 104.
Type locality: Kuh-i-Gahkum, Iran.
Horizon: The holotype specimen was collected from the horizon below the horizon which yields "*Pseudoschwagerina*". Hence the species is here considered to be from the lower Permian, *Pseudoschwagerina* zone.

Remarks: The present species is very simple in its skeletal construction, which we consider to be of primitive nature. Corallites are small, dissepiments are only in one row, and tabulae are complete and only gently inclined towards the simple axial column of very small size. No true elongate dissepiments or clinotabulae are observable.

This form may have given rise to *Pseudohuangia cincta* and *counilloni* later on.

Pseudohuangia counilloni (MANSUY)

1912 *Lonsdaleia counilloni* MANSUY, p. 9, pl. 1, figs. 2a–g.
1961 *Liangshanophyllum counilloni*, FONTAINE, p. 171, p.l 35, figs. 1–2.
Holotype: MANSUY collection, Museum of Paleontology, Ecole des Mines.
Type locality: Pong-Oua, near Luang Prabang, Laos.
Geological horizon: MANSUY stated that the species was obtained from the *Neoschwa-*

gerina limestone. FONTAINE reported the range of this form to be *Neoschwagerina* zone or *Yabeina* zone, (" Koungurien ou Kazanien ").

Remarks: This species is comparable to *Pseudohuangia minima* and *cincta* from Iran, but differs from them in having dendritic corallum, and a relatively wider axial column. *P. cincta* has larger corallites and the *minima* has smaller corallites than those of *counilloni*. The dissepimentarium of *counilloni* is slightly wider in two rows compared to the single row of *minima*.

Pseudohuangia stoecklini sp. nov.

Pl. 5, figs. 1–2.

1939 *Waagenophyllum texanum*, HERITSCH (non *texanum* HERITSCH, 1936), p. 8, pl. 2, fig. 2.
1955 *Waagenophyllum cinctum*, FLÜGEL, p. 198, pl. 33, fig. 3.
1955 *Waagenophyllum tabellatum*, FLÜGEL, p. 299, pl. 33, fig. 4.
1955 *Waagenophyllum* cfr. *tabellatum*, FLÜGEL, p. 299, pl. 34, fig. 5.
1955 *Waagenophyllum persicum*, FLÜGEL, p. 300, pl. 34, figs. 6a–b.
1955 *Horitschia chitralica*, FLÜGEL, p. 307, pl. 35, fig. 11.
1955 *Heritschia parachihsiaensis*, FLÜGEL, p. 308, pl. 35, fig. 12.
Holotype: U.H.R. 18298: Replicas (18299–18306).
Type locality: South flank of Kuh-e-Jamal, Southeast of Tabas, East Iran.
Collector: J. STÖCKLIN, Geol. Survey of Iran.
Other localities: North Ala Dag, Goktepe, Bolkar Dag of south anatolian Taurus, Turkey.

Description: Corallum compound. Corallites partly dendroid and partly phaceloid, viz. corallites are locally in contact with a common wall and are mostly apart more or less from each other in the cross section; while they are partly sub-parallel in disposition and partly irregularly branching in the longitudinal section.

Corallites are fairly large, the diameter of which usually exceeds 10 mm in the ephebic stage.

The wall is originally very thin without any remarkable deposits, however septa are so thick at the wall that the wall itself may be sometimes misunderstood to be thick in some part. Septa are thin except at the wall, and slightly wavy or flexuous in the peripheral zone, which become however slightly thicker inwards especially from the indistinct inner wall composed of the outermost edges of clinotabulae or elongate dissepiments. Finally, they again become gradually thinner towards the axial ends.

Septa are of two orders, numbered 30 plus 30 at their maximum development. The major septa are long, nearly reaching the axial structure, but never directly intruding into the columella. Both major and minor septa always begin

to grow from the wall. And there is accordingly no non-septal area at all at the peripheral zone. Minor septa are far shorter than the major ones, and they are thin towards both ends and slightly thickend near the inner wall.

Columella is large, and well bounded from the other skeletal elements. The diameter of columella measured in the para-longitudinal section is slightly longer than that of ortho-longitudinal section. In any event, the diameter of columella is, however usually approximately 1/4 the length of calicular diameter and never exceeds 1/3 the length of the latter. Columella is irregular and varies in appearance in the cross section. For instance, even in a single columella, half of which is sometimes constructed by rather regularly and densely arranged axial tabellae and septal lamellae representing a spider web structure to some extent, while the other half is obviously composed of loosely arranged lamellae and tabellae. In the columella the median plate is however always distinct, but is not especially thick. It has a considerable length and completely bisects the axial structure. Notwithstanding this, the median plate does not directly unite with the counter or cardinal septum.

The dissepiments in the peripheral area are rather sporadically distributed in the cross section. Mostly they are sub-concentric in arrangement but are locally angulo-concentric. Further, some interseptal dissepiments are so steeply inclined with each other that their convex sides meet in the middle portion of the interseptal area; the result gives the appearance of the dissepiments forming a short septum.

The elongate dissepiments and clinotabulae are not curved as in the globose dissepiments in the cross section and more densely distributed in the intrathecal area.

In the longitudinal section, globose dissepiments are subequal in size, arranged in two or three rows, facing their convex sides upwards and at the same time inwards. Elongate dissepiments are not uniformly distributed throughout the dissepimentarium, but fairly large ones are locally developed.

Steeply inclined clinotabulae are also locally well developed, although they are generally lacking in most parts of the tabularium. The transverse tabulae are wide, nearly horizontal or slightly sag downwards. The columella is composed of a prominent median plate and numerous and steeply ascending tabellae forming a typical cone in cone structure.

Remarks: At a glance the present form may be similar to forms of *Waagenophyllum*. However, it has an axial column of " clisiophyllid " appearance, intrathecally thickened major septa and wide transverse tabulae. Therefore the present form is here assigned to the *Pseudohuangia*.

Many Turkish forms described by HERITSCH (1939) and FLÜGEL (1955) apparently represent a group, though it seems to be a mutable one, which resembles and is assignable to the present new species. See the above list of synonyms.

The present new species is related to other Iranian forms of *Pseudohuangia*

in some respects. Among forms *Pseudohuangia persica* and *chitralica* may be comparable to the present species. But the present species is distinguishable from the two species above mentioned in having large corallite, a large and well bounded axial column, rather broad dissepimentarium and steeply inclined clinotabulae. Geological age: The holotype of the present species is found in association with a form of *Wentzelophyllum*, which is similar to "*Lonsdaleia chaoi*" of HUDSON from North Iraq. The Iran specimen was obtained from the horizon above the *Michelinia* bed with *Polydiexodina*.

Turkish forms assigned to the present species were found in association with species of *Michelihia*, "*Stylidophyllum*", "*Wentzelella*" and *Hayasakaia*, in many Anatolian localities. Hence Turkish forms as a whole denote a horizon correlatable with the Chinese Chihsian.

Thus we consider the species now in question to be ranging from *Pseudofusulina* to *Parafusulina* zone.

Pseudohuangia tsengi (ZHAO et CHEN)

1963 *Waagenophyllum* (*Liangshanophyllum*) *tsengi* ZHAO & CHEN, pp. 386–387, 399–400, pl. 2, figs. 5a–b.

Holotype: Nos. 14211–2, Paleont. Inst. Nanking, China.

Type locality: Dafengcun, Hanshan, Anhui, China.

Geological Horizon: The species occurs below *Hayasakaia elegantula* horizon, and above *Stylidophyllum kueichowense* horizon, of the Chihsia limestone in Anhui.

Remarks: Although the authors originally compared the present species with other species of *Waagenophyllum* (*Liangshanophyllum*) it much resembles species of *Pseudohuangia* in having ill developed elongate dissepiments and less inclined tabulae occupying wide tabularium. The present species most closely resembles "*Corwenia*" *chiuyaoshanensis* HUANG, but the former is distinguishable from the latter in posessing comparatively long minor septa, wide tabularium with subparallel tabulae gently inclining towards the axial column.

Genus ***Waagenophyllum*** HAYASAKA, 1924

Type species by subsequent designation (GRABAU, 1932); *Lonsdaleia indica* WAAGEN et WENTZEL, 1886.

Synonymy: 1886 *Lonsdaleia* (aberrant species), WAAGEN et WENTZEL, p. 897
1915 *Lonsdaleia* (*Waagenella*) YABE et HAYASAKA, p. 96 (34) (non *Waagenella* de KONINCK 1883)
1924 *Lonsdaleia* (*Waagenophyllum*), HAYASAKA, p. 23

1931 *Waagenophyllum*, GRABAU, p. 42
1932 *Waagenophyllum*, HUANG, p. 46
1935 *Waagenophyllum*, SMITH, p. 32
1938 *Waagenophyllum*, CHI, p. 176
1941 *Waagenophyllum*, SMITH, p. 8
1944 *Waagenophyllum*, SHROCK and SHIMER, p. 89
1948 *Waagenophyllum*, TSENG, p. 97
1950 *Waagenophyllum*, WANG, p. 212
1950 *Waagenophyllum*, YABE, p. 78
1955 *Waagenophyllum*, WANG, YÜ and YOH, p. 42
1956 *Waagenophyllum*, HILL, F. 309
1957 *Waagenophyllum*, WU, pp. 326, 335
1958 *Waagenophyllum*, HUDSON, p. 178
1961 *Waagenophyllum*, FONTAINE, p. 164
1962 *Waagenophyllum*, YÜ, p. 7–8

Generic diagnosis: Fasciculate Waagenophyllidae without tertiary or more orders of septa. Axial column present. Stereowall may develop but lonsdaleoid dissepiments are almost lacking with a few exceptional cases. Transverse tabulae may be largely or nearly entirely replaced by well developed clinotabulae. Proper globose dissepiments may be variously developed and sometimes suppressed altogether especially in more specialized forms in which globose dissepiments are replaced by large elongate dissepiments.
Remarks: *Heritschiella* differs from *Waagenophyllum* here defined in having a compact axial column, broad dissepimentarium, numerous septa and comparatively wide tabularium with sub-horizontal transverse tabulae.

Waagenophyllum can be divided into four subgenera, namely *Waagenophyllum* s. str., *Liangshanophyllum*, *Huayunophyllum* and *Chaoiphyllum*. Of these, *Liangshanophyllum* has tabularium with relatively broad transverse tabulae. While *Huayunophyllum* possesses rather simply constructed axial structure, and *Chaoiphyllum* is almost lacking in axial structure and has lonsdaleoid dissepiments.

Geologic distribution: *Pseudofusulina* to *Yabeina* zone. Chihsian to Liangshanian in South China.
Geographic distribution: Japan, Mongolia, N.E. China, South China, Indochina, New Zealand, Burma, Pakistan, Himalaya, Iran, Iraq, South USSR, and Yugoslavia.

Subgenus ***Waagenophyllum*** HAYASAKA, 1924

Synonymy: See the genus *Waagenophyllum*.
Type species: As for the genus *Waagenophyllum*.

Subgeneric diagnosis: *Waagenophyllum* with highly developed clinotabulae and elongate dissepiments.

Geologic distribution: *Parafusulina* to *Yabeina* zone.
Geographic distribution: As for the geographic distribution of *Waagenophyllum*.

Included species:

Waagenophyllum (*Waagenophyllum*) *huangi* DOUGLAS
W. (*W.*) *kueichowense* HUANG
W. (*W.*) *yunnanense* CHI
W. (*W.*) *simplex* WU
W. (*W.*) *wengchengense* HUANG
W. (*W.*) ? *longiseptatum* TSENG
W. (*W.*) *polyseptatum* MINATO
W. (*W.*) *smithi* sp, nov.
W. (*W.*) *indicum* (WAAGEN et WENZEL)
W. (*W.*) *novaezelandiae* LEED
W. (*W.*) *virgalense* (WAAGEN et WENTZEL)
W. (*W.*) *pulchrum* HAMADA
W. (*W.*) *compactum* sp. nov.
W. (*W.*) *akasakense* (YABE)

Key to the species of *Waagenophyllum* (*Waagenophyllum*)

I. Septa thin. Stereozone absent.
  A) Axial column small, the diameter of which being less than 1/3 the length of the calicular diameter.
    a) With well developed globose dissepiments arranged in more than two rows.
      Septa less numerous ..... *huangi*
      Minor septa short ..... *kueichowense*
      Minor septa long, with lonsdaleoid dissepiments ..... *longiseptatum*
      Corallites large, with lonsdaleoid dissepiments ..... *polyseptatum*
      Corallite small. Axial column with distinct medial plate ..... *simplex*
    b) With less developed globose dissepiments arranged in a single row ..... *wengchengense*
  B) Axial column is intermediate in size. The diameter being approximately 1/3 the length of calicular diameter.
    a) With well developed globose dissepiments ..... *yunnanense*
    b) With ill developed globose dissepiments. Axial column loosely constructed ..... *indicum*

II. Septa thick. Stereozone present.

A) With relatively small axial column. The diameter being less than 1/3 the length of calicular diameter. Stereozone very thick. Globose dissepiments ill developed ..... *virgalense*

Globose dissepiments well developed. Septa become thin in mature stage ..... *pulchrum*

Corallites small. Globose dissepiments ill developed ..... *akasakense*

Corallites small. Globose dissepiments ill developed. Axial column compact ..... *smithi*

B) With relatively large and compact axial column ..... *compactum*

C) With large axial column. The diameter being larger than 1/3 the width of corallite ..... *novaezelandiae*

Waagenophyllum* (*Waagenophyllum*) *kueichowense HUANG

Text—fig. 47–1.

1897 *Lonsdaleia* sp., LOCZY, p. 88, pl. 5, fig. 8.
1932 *Waagenophyllum indicum* var. *kueichowense*, HUANG, p. 48, pl. 3. figs. 1–2; text-fig. 3.
1950 *Waagenophyllum* aff. *indicum*, DOUGLAS, p. 9, pl. 1, figs. 1, 1a.
1958 *Waagenophyllum indicum* var. nov. (unnamed), HUDSON, p. 178, pl. 33, figs. 4, 9.
Holotype: Cat. no. 3856, V.K. TING, coll. Geol. Surv. China.
Type locality: Middle Permian beds of Pahui, Lipohsien, Kueichow, China.
Horizon: *Neoschwagerina* zone at its type locality. However it may be ranging from the *Parafusulina* zone up to the Middle Permian.
Geographic distribution: Iraq, Iran and China.

Specific diagnosis: *Waagenophyllum* with medium to small corallites, in which the axial column is also very small, the diameter of which is always less than 1/3 the length of the calicular diameter. Globose dissepiments are fairly well developed, besides large elongate dissepiments and clinotabulae. Minor septa are short, which are generally 1/2 or less than 1/2 the length of major ones.

Remarks: HUANG placed (1932) the present species under a varietal form of *Waagenophyllum indicum*. Superficially the resemblance between two forms above stated cannot be denied. However, the present form definitly has more numerous globose dissepiments. In addition, the axial column of the present form occupies a more narrower space. Further, the present form possesses shorter minor septa, which are always less than 1/2 the length of the major septa. Thus the distinction between the two forms is quite obvious, so that the present form would be best specifically distinguished from the type species of the genus *Waagenophyllum*.

The coral described and figured by HUDSON from Northern Iraq as *Waagenophyllum indicum* var. nov. cannot be specifically distinguished from the present

species in our opinion, since the coral now in question is closely similar to the latter in septal number, calicular diameter, length of minor septa, development of globose dissepiments, and size and construction of axial column. Further, the HUDSON's coral possesses longer major septa which are as long as the ones of the present species.

Of course, the two forms above stated have corallites showing variable nature in size, septal number and construction of axial column, even though in the mature stage.

For instance, the corallites of the HUDSON's coral show the calicular diameter to range from 4.4 to 6.0 mm, whereas the holotype of the present species from 5.0 to 6.0 mm and septal number ranges from 19 to 22 in HUDSON's specimens, while in HUANG's type specimen they are 20 to 21. Also the diameter of axial column ranges from 1/3.4 to 1/5.2 of the length of the calicular diameter in the HUDSON's specimens, while it is between 1/3.1 to 1/4.8 in HUANG's specimen. All such measurements are based only on the corallites illustrated by HUDSON and HUANG, but the variabilities above enumerated can be safely regarded to be within the limit of specific rank.

The specimens described by HUDSON were scree specimens composed of three pieces, which were collected at Geli Khana, Ora, northern Iraq. The exact horizon of this coral is thus unknown, but according to HUDSON, this was found below the *Wentzelella* limestone there. In all probability, the age may be accordingly the *Parafusulina* zone.

The Iranian coral once described by DOUGLAS as *Waagenophyllum* aff. *indicum* seems to be also entirely conspecific with the present form, the exact age of which is unknown to us, but it may be possibly the upper part of the Lower Permian from the correlation table and faunal list given by DOUGLAS.

Waagenophyllum* (*Waagenophyllum*) *huangi DOUGLAS

1950 *Waagenophyllum huangi* DOUGLAS, p. 12, pl. 1, figs. 7, 7a.
Holotype: A.O.I.C. 119. (See DOUGLAS, 1950).
Locality: Bampur basin, Iran.
Horizon: *Yabeina* zone.

Specific diagnosis: *Waagenophyllum* with less numerous septa and very narrow axial column.

Remarks: Compared to the preceding species, *W. kueichownese*, the present form has corallites which are similar in size. Inspite of this, septa are generally far less numerous in the present form. Only 16 were counted in the mature stage. Further, the minor septa of the presnt species are a little longer in general than *W. kueichowense*. In addition, the axial column is more simply constructed

than *kueichowense*. Except for those minor points, the present form does not show any marked difference from *Waagenophyllum kueichowense*.

Waagenophyllum (*Waagenophyllum*)? *longiseptatum* TSENG

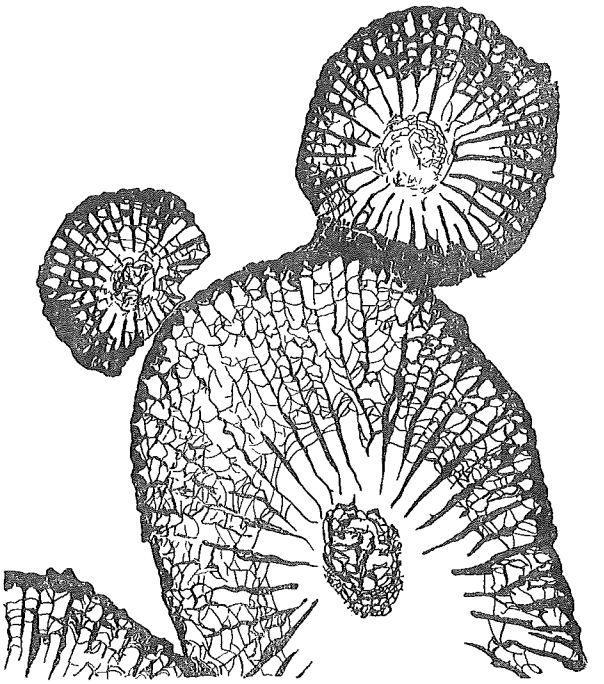
1949 *Waagenophyllum longiseptatum* TSENG, p. 98, pl. 1, figs. 4a, b.
Non *Waagenophyllum longiseptatum* YOKOYAMA, 1960, p. 241, pl. 28, fig. 39e.
Holotype: Col. no. f 19–(e), Cat. no. 6947. Geol. Surv. China.
Locality: Tungkaitze village, Szechuan, China.
Horizon: Lower part of the Maokou limestone. It is said to be associated with *Pleurodictyum microstoma*, *P. pectiniformis*, *P. siyangensis*, *Wentzelella timorica*, *W. subtimorica*, *W. flexuosa*, *W.* sp. *Yatsengia asiatica* var.
Specific diagnosis: Fasciculate? Waagenophyllidae with very closely distributed corallites which show a tendency to be almost prismatic in appearance. Septa are thin. Both major and minor septa are very long, besides the minor septa being as long as the major ones. Axial column occupies rather narrow space. Globose dissepiments are well developed which locally tend to be lonsdaleoid at the peripheral area especially near the wall.
Remarks: TSENG has already well described this coral and nothing seems necessary to be added.

However, we assign this coral into *Waagenophyllum* (*Waagenophyllum*) with a slight doubt, because the present species shows some characteristics which might be assignable into the genus *Ipciphyllum* in certain points. First of all, the present form possesses a corallum which is somewhat prismatic, although it can be regarded to be a fasciculate form as a whole. Secondly, the existence of lonsdaleoid dissepiments in the narrow peripheral area is remarkable, although such dissepiments are not abundantly found in the present species.

However, the present form has very narrow transverse tabulae. Further, in the present form, clinotabulae and elongate dissepiments are fairly well developed. Thus it may be more reasonable to regard the present species to be placed into *Waagenophyllum* rather than *Ipciphyllum*.

In the meantime, the present species somewhat remind us of *Akagophyllum hasegawai* in certain points. Both of them possess thin septa, weakly developed lonsdaleoid dissepiments, and show a somewhat prismatic nature at least in some part of the corallum. However, in the latter, the transverse tabulae are definitly wide, besides elongate dissepiments and clinotabulae are not so well developed as the present species. Thus they cannot be viewed to be congeneric with each other.

If we paid attention only to the different length of minor septa, the specific distinction between the two forms above mentioned would be beyond doubt.



Text-figure 35
Waagenophyllum (*Waagenophyllum*) *polyseptatum* MINATO
(×3.6); Akasaka, Gifu Prefecture.
Yabeina—Neoschwagerina zone. UHR 16476

Waagenophyllum* (*Waagenophyllum*) *polyseptatum MINATO

Text-figs. 35–37, 48 po.

1955 *Waagenophyllum polyseptata* MINATO, p. 106, pl 21, fig. 3.
Holotype: UHR no. 15526.

Remarks: The present species is characteristic in having large corallites in which there are more than 30 major septa alternating with the same number of minor septa. Formerly, the senior author reported the presence of tertiary septa from this species. But, it was observed that this may be not the case from recent detailed observations, since the so-called tertiary septa are only disposed on both sides of cardinal septum and counter side of both alar septa, but not regularly distributed throughout all parts of corallites observed. Further such shorter septa sometimes are not found in certain corallites, even in full grown stage. Therefore the septa

Text-figure 36
Waagenophyllum (*Waagenophyllum*) *polyseptatum* MINATO (× 3.6); Akasaka, Gifu Prefecture.
Neoschwagerina—*Yabeina* zone. UHR 15554.

formerly described as tertiary septa would be better interpreted as septa being not full grown.

The present form is also characteristic in having numerous globose dissepiments, which are accidentally and only locally tended to be lonsdaleoid.

Lastly, the present species seems to be characteristic in having corallites, branching with large angles. The restored corallum will be shown in the text figure 48.

Geological horizon: *Neoschwagerina* to *Yabeina* zone.
Specimens in our repository: Nos. 15526, (Holotype), 15512, 15513, Tsukitate, Motoyoshi-gun, Miyagi Prefecture. *Neoschwagerina* zone. Nos. 9959, 9958, 9935, 15533, Kahan, Kinsyozan, Akasaka-machi, Fuwa-gun, Gifu Prefecture, *Yabeina* limestone.

Text-figure 37

Waagenophyllum (*Waagenophyllum*) *polyseptatum* MINATO (× 3.6); Akasaka, Gifu Prefecture.
Yabeina—Neoschwagerina zone. UHR 15534.

Waagenophyllum (*Waagenophyllum*) *simplex* WU

1957 *Waagenophyllum simplex* WU, p. 327, and 336, pl. 1, figs. 1, 2.
1957 *Waagenophyllum lui*, WU, p. 325, p. 327, pl. 1, figs. 3, 4.
Holotype: Cat. nos. 8819 and 8820. Academia Sinica.
Type locality: Middle part of the Wuchiaping limestone about 3 km. SE. of Yen-erh-wuo, Liangshan, S. Shensi, China.
Horizon: Possibly upper part of the *Yabeina* zone.

Specific diagnosis: *Waagenophyllum* with relatively small corallites in which the axial column is always very small. The axial column is very simply constructed in which median plate is however nearly always discernible. Septa are thin.

Minor septa are 1/2 to 2/3 the length of the major ones. Globose dissepiments are well developed, besides having a large number of clinotabulae and elongate dissepiments. Transverse tabulae are almost obsolete.

Remarks: The present form is closely akin to *Waagenophyllum kueichowense* HUANG in general construction of corallites, since, the columella is small in size and globose dissepiments are rather numerous. As a matter of fact, we hesitated at first to specifically distinguish the present form from the latter.

However, the present species possesses decidedly smaller corallites than the latter and the columella seems to be somewhat more simply constructed. Further, the median plate is a little more distinct in the present species. Based on the three points above mentioned we finally agreed to regard the present form to be specifically distinct from *W. kueichowense*.

WU distinguished the present species from the coral called *W. lui*. It may have been based on the fact that the size of corallites is not identical with each other. Except for this point, there is however hardly any marked difference discernible between them. Accordingly this is not sufficient as a criterion to separate the two forms as distinct species.

The present species also somewhat resembles *Waagenophyllum wengchengense* HUANG but differs from the latter in having more numerous globose dissepiments.

Waagenophyllum* (*Waagenophyllum*) *wengchengense HUANG

1932 *Waagenophyllum wengchengense* HUANG, p. 50, pl. 3, fig. 3.
Non *Liangshanophyllum wengchengense*, TSENG, 1949, p. 103, pl. 1, figs. 1a, b.
1957 *Liangshanophyllum wengchengense*, WU, p. 338, pl. 2, figs. 3, 4.
1936? *Waagenophyllum* aff. *omiensis*, DOUGLAS, pp. 22–23, pl. 1, fig. 3.
Holotype: Cat. no. 3858, Geol. Surv. China.
Type locality: Permian limestone between Wengchengchiao and Tsungpachieh, Kueitinghsien, Kueichow, V. K. Ting Coll. Loc. no. T103n.
Geological horizon: Middle or Lower Permian?
Geographic distribution: China and ?Iran.

Specific diagnosis: *Waagenophyllum* with small axial column. Globose dissepiments are less developed, which are generally arranged only in a single row.

Remarks: The present species is closely allied to the preceding species, *W. simplex* WU from the size of corallites, septal number, construction of columella and its size. However, the present form is characteristically thin in the peripheral area where it is occupied by globose dissepiments. In the longitudinal section of this form, reported by WU, the globose dissepiments are arranged in a single row, against a few rows in *W. simplex*. This form, now in question seems accordingly to be slightly progressive as compared to *simplex*.

The longitudinal nature of the holotype of the present species is unknown to us at the present. Further, the exact geological horizon of this species is also unknown, although HUANG described it to be Lower or Middle Permian.

It is also quite difficult to determine, whether WU's specimens are exactly conspecific with HUANG's holotype, because no information is available on the longitudinal nature of the holotype. However, if WU's specific identification is entirely correct (and it may be highly probable), the present species may show its geological range at least to be Upper Permian, possibly the *Yabeina* zone. However, it may also be probable that the present species ranges down to the Middle Permian, that is to say the *Neowschwagerina* zone.

Waagenophyllum (*Waagenophyllum*) *yunnanense* CHI

1938 *Waagenophyllum yunnanense* CHI, p. 177, pl. 2, figs. 3a, b.
1963 *Waagenophyllum tambense*, SAKAGUCHI and YAMAGIWA, p. 111, p. 2, figs. 3a, b.
Holotype: Cat. no. 6607, Geol. Surv. China.
Type locality: The Chihsia limestone (Yangsinian) at Siaokaitsu, southeast of Kuangnanhseien city. Locality: no. YL59.
Horizon: *Parafusulina* zone?
Geographic distribution: China and Japan.

Specific dagnosis: *Waagenophyllum* with relatively large sized axial column, in which the median plate is discernible, although septal lamellae and axial tabellae are rather loosely disposed. Globose dissepiments are fairly well developed, besides having prominent clinotabulae and elongate dissepiments. Septa are thin except at their base near the wall.

Remarks: In respect to the size of axial column, the present form may be somewhat comparable to the type species of *Waagenophyllum*, however the present form is decidedly larger in corallites which possess more numerous septa. In addition to this, the present form has definitly a larger number of globose dissepiments besides having elongate dissepiments.

The present form may also somewhat resemble *Waagenophyllum pulchrum* HAMADA, but differs from the latter in the dilation of septa.

The species newly described by SAKAGUCHI and YAMAGIWA from the Tamba district, Central Japan, as *Waagenophyllum tambense* appears to be somewhat different from the present species, owing to the different nature of preservation, at least as far as the presented specimens are concerned.

However, the so-called *tambense* is in reality identical with present species in the size of corallites, septal number, length and thickness of septa, and construction of axial column.

The axial column in both forms is rather loosely constructed in the cross sec-

tion in which the median plate is however relatively distinct. In addition to this, the diameter of the axial column of both forms is approximately 1/3 the length of the calicular diameter. Further, normal globose dissepiments are well developed in those two forms, in spite of highly developed clinotabulae and elongate dissepiments. Of course, transverse tabulae are extremely narrow in the two forms.

Accordingly, we are now of the belief that the Japanese form *tambense* is entirely conspecific with *yunnanense*.

According to CHI, the present form denotes the *Parafusulina* zone in China, whereas in Japan the present species is said to represent the *Neoschwagerina* or possibly the *Yabeina* zone by SAKAGUCHI and YAMAGIWA. Hence the present species may range from the *Parafusulina* up to the *Yabeina* zone.

Waagenophyllum* (*Waagenophyllum*) *indicum (WAAGEN et WENTZEL)

Text-figs. 47–3, 4 & 48 i.

1886 *Lonsdaleia indica* WAAGEN and WENTZEL, p. 897, pl. 101, figs. 1–3, non pl. 115, figs. 3, 4.
1897 *Lonsdaleia indica*, DIENER, p. 82, pl. 13, figs. 5–6.
Non *Lonsdaleia indica*, REED, 1911, p. 43, pl. 6, fig. 4.
Non *Lonsdaleia indica*, SMITH in REED, 1925, p. 14, pl. 1, Figs. 24–27.
Non *Lonsdaleia indica*, SEN, 1931, p. 10, pl. 1, fig. 1–2.
? 1941 *Waagenophyllum indicum*, SOSHKINA et al., p. 174, text-figs. 42–44.
1943 *Waagenophyllum indicum*, MINATO, pl 52, pl. 1, figs. 1–4.
Non *Waagenophyllum indicum*, MINATO, 1955, p. 102, pl. 21, figs. 1–2, pl. 26, figs. 2, 4, 5, 6, and 8.
1955 *Waagenophyllum indicum* var. *usuginuense* MINATO, pl. 103, pl. 19, fig. 3, pl. 31, fig. 1.
1957 *Waagenophyllum indicum* var. *crassiseptatum*, WU, p. 336, pl. 1, figs. 5, 6.
Non *Waagenophyllum indicum* var. nov. HUDSON, 1958, p. 178, pl. 33, figs. 4, 9.
Non *Waagenophyllum indicum*, SAKAGUCHI and YAMAGIWA, p. 175, pl. 5, figs. 4–7.
? 1961 *Waagenophyllum indicum* var. *kueichowense*, FONTAINE, p. 167, pl. 32, fig. 6.
1962 *Waagenophyllum indicum*, MINATO in KAMEI et al, p. 34, text-figs. 3, 4.

The type here designated are the apecimens illustrated as figs. 1, 2 and 3 on plate 101 by WAAGEN and WENTZEL.

Type locality: The middle Productus limestone on the road from Chidru to Musahkeyl, Salt range, Pakistan.

Geographical distribution: Transcaucasia, Pakistan, Himalaya, Vietnam, N.E. China and Japan.

Geological age: Middle to Upper Productus limestone, hence, *Neoschwagerina* to *Yabeina* zone.

Specific diagnosis: *Waagenophyllum* with a thin wall providing without stereozone. Septa also thin. The diameter of axial structure is approximately one third the

length of the calicular diameter.

Elongate dissepiments and clinotabulae are highly developed, yet a few globose dissepiments may be still retained.

Remarks: This species may be quite unique in having less developed globose dissepiments, though not completely lacking, against highly developed clinotabulae and elongate dissepiments.

The coral specimens given by WAAGEN and WENTZIE in figs. 3 and 4 of plate 115 have dissepimentarium provided with rather numerous globose dissepiments. Accordingly they may belong to a different spieces other than the type species of *Waagenophyllum*.

In establishing *Waagenophyllum virgalense*, WAAGEN and WENTZEL stated that they first hesitated to separate this form from *indicum*. SMITH in REED (1925) questioned about the separation between the two forms above stated, and thought that *virgalense* might be a small variety of *indicum*. SEN (1931) also said the two forms were the same.

However, the differences between the two are, in our opinion, that in *Waagenophyllum virgalense* corallites are small and that a well marked stereozone is present. In addition the zone of transverse tabulae appears to be rather broad in comparison with *indicum*. Therefore we consider that both of the two coral established by WAAGEN and WENTZEL are valid, and specifically separable from each other.

SEN (1931) studied *Waagenophyllum* from the Salt Range, which has a little smaller corallites and less large axial column. It may be perhaps not entirely conspecific with the present form.

While the coral once described by the author from the Permian of the Kitakami mountains under the name of the *Waagenophyllum indicum* var. *usuginuense* has in reality larger corallites than the typical form of the present species and numerous septa. In these respects, the variety proposed can be distinguished from the typical form. However, other characters of the so-called *usuginuense* are not unlike *indicum*'s, in their well developed clinotabulae and elongate dissepiments and in their thickness of septa, less numerous globose dissepiments, size of axial column etc. Therefore, we are now inclined to regard *usuginuense* to be a mere larger form belonging to *indicum*.

Specimens in our repository (UHR): Reg. nos. 16786, 16787, 16789, 16792 (Iwaizaki, Motoyoshi-gun, Miyagi Prefecture); Reg. nos. 15551, 15556, Katchisawa, Setamai, Kesen-gun, Iwate Pref., Reg. nos. 15552, Sanmai-yashiki, Higashi-iwai-gun, Iwate Prefecture. Reg. nos. 18181–18188, Utouyama, Nojiri, Nagano Prefecture, Japan; Reg. no. 15093, 15094, 15100, 15266–15268, 15270 Kaishantun, Province Chientao, S. E. Manchuria, China.

Waagenophyllum (*Waagenophyllum*) *virgalense* (WAAGEN et WENTZEL)

Pl. 7, fig. 2; Text-figs. 38–41, 48 v.

1886 *Lonsdaleia virgalense* WAAGEN and WENTZEL, p. 900, pl. 101, fig. 4; pl. 111, figs. 1a–c.
1911 *Lonsdaleia indica*, DIENER, p. 43–44, pl. 6, fig. 4–
1912 *Lithostrotion mixtum* MANSUY, p. 38–39, pl. 8, figs. 5a–c.
1912 *Lithostrotion Jourdyi* MANSUY, p. 69, pl. 13, figs. 5a–b.
1931 *Waagenophyllum virgalense* var. *mongoliense* GRABAU, p. 42, pl. 1, figs. 8, 9.
1955 *Waagenophyllum indicum*, MINATO, p. 102, pl. 21, figs. 1, 2; pl. 26, figs. 2, 4, 5, and 8.
? 1958 *Waagenophyllum indicum*, SAKAGUCHI and YAMAGIWA, pl. 175, pl. 5, figs. 4–7.
1958 *Waagenophyllum indicum*, RAMOVS, p. 482–3, pl. 1, figs. 2–3.
1961 *Waagenophyllum indicum*, FONTAINE, p. 165–166, pl. 33, figs. 5a–b.
1961 *Waagenophyllum mixtum*, FONTAINE, p. 168, pl. 29, fig. 6; pl. 33, fig. 7.

Lectotype: (here chosen) A specimen given by WAAGEN & WENTZEL in fig. 4 on their plate CI, 1887.
Type locality: Virgal, Salt Range, Pakistan.
Horizon: Middle Productus limestone.
Geologic distribution of the species: *Neoschwagerina* to *Yabeina* zone.
Geographic distribution: Japan, Mongolia, Burma, Pakistan, Indochina and Yugoslavia.

Specific diagnosis: *Waagenophyllum* with corallites rather variable in size, although they are small in general. Septa are very thick in the peripheral area forming a definite stereozone. Large elongate dissepiments and clinotabulae are highly developed, while globose dissepiments and transverse tabulae are ill developed. Minor septa are mostly short.

Description of the Japanese specimens: Corallum composite, fasciculate. Corallites usually small, their calicular diameter usually less than 5.5 mm in length, however it attains sometime 6.5 mm. Major septa are also variable in number, generally 20 and as many as 24 may be counted. The minor septa alternating with the major ones are in general nearly half the length of the major septa. Septa are sometimes not straight in the cross section, but zig-zag, especially in the dissepimental zone, and seem accordingly to provide a carinae like process. In the early neanic stage, when the central area is well spaced providing no axial structure, bilateral symmetry is pronounced in the septal arrangement in which four primary septa are well distinguished from other longer septa. In the later neanic stage, when the axial structure begins to grow and dissepimentarium becomes wider, septa also become quite dilated. In the ephebic stage, both major and minor septa grow longer and they are completely joined with each other, at least in the peripheral area, so that interspaces become very narrow representing black lines.

Septa are of the diffuso-trabecular type as a whole, in which the translucent layer is commonly lacking or only poorly retained, and the black coloured zone seems accordingly to be not clearly divided into two rows.

The axial structure occupies a rather narrow space in general, which is usually loosely constructed with less numerous septal lamellae and axial tabellae. The median plate seems to be not entirely lacking but by no means distinct in any of the corallites observed. At least it is not straight and does not directly unite with counter and cardinal septum.

Result of measurements of some corallites in the specimen (Reg. no. 15522)

	c. d.	mj. s.	mi. s.	axial structure
Neanic stage	2.0	9	9	none
	2.5	14	14	poor developing
	3.5	17	17	present
Ephebic stage	4.5	19	19	well developing
	5.0	19	19	well developing
	5.0	20	20	well developing

c.d: calicular diameter, mj. s: number of major septa, mi. s: number of minor septa.

In the longitudinal section, large elongate dissepiments and clinotabulae are highly developed and globose dissepiments seem to be almost entirely lacking. In the axial structure, tabellae steeply incline to form an acute cone, in which the median plate is discernible but not straight and irregularly curved.

Remarks: We lately became aware of the fact that there are actually two forms, among corals in Japan, which have been listed or described under the name of *Waagenophyllum indicum*. One of them has small corallites in which septa and wall are thick, strengthened by stereoplasmic desposits. In other words this is *Waagenophyllum virgalense*, instead of *W. indicum*. On the contrary, the other form is represented by such forms having relatively larger corallites with thin septa and a thin wall without stereozone and is certainly assignable into the type species of *Waagenophyllum*.

The specimens now in question with certainty belong to the first form. From the phaceloid form of corallum, size of corallites, septal number, length and thickness of septa, size and structure of the axial column, they cannot be specifically distinguished from the Salt range coral, *virgalense*.

Concerning the nature of dissepimentarium, the Japanese specimens seem, however to be slightly more specialized than the Salt range form, at least as far as the specimens illustrated by WAAGEN and WENTZEL are concerned. Namely, in our specimens, nearly the entire space of dissepimentarium seems to be occupied by only elongate dissepiments, although common globose dissepiments are not entirely lacking.

Text-figure 38

Waagenophyllum (*Waagenophyllum*) *virgalense* (WAAGEN et WENTZEL) (×3.7)
Iwaizaki, Kesennuma city, Miyagi Prefecture.
Neoschwagerina zone. UHR 15552

Nevertheless, our specimens would be better indentified to the Salt range coral *virgalense*, because even in the typical specimens of *virgalense*, we know that common globose dissepimental vesicles are sometimes very poorly developed and are locally arranged in a single row. Further, the Japanese specimens do not show any difference in their other skeletal morphology in comparison with the Salt range coral.

Next, the synonymity between *Waagenophyllum virgalense* and the so-called *Waagenophyllum indicum* var. *mongoliense* described by GRABAU from Jisu Honguer, Mongolia will be discussed. GRABAU once described the presence of four orders of septa in his species. His primary and secondary septa are, however, our major septa and his tertiary septa are in reality our minor septa. Then GRABAU's quaternary septa accordingly mean the tertiary septa in our sense.

It is however, an open question, whether there are actually developed tertiary septa in the Mongolian specimens. In this regard, we have, of course no conviction, because we have never directly observed the Mongolian specimens described by GRABAU. So far as the figures, given by GRABAU are concerned, however, the so-called quaternary septa appear to us to be nothing but interspace between major

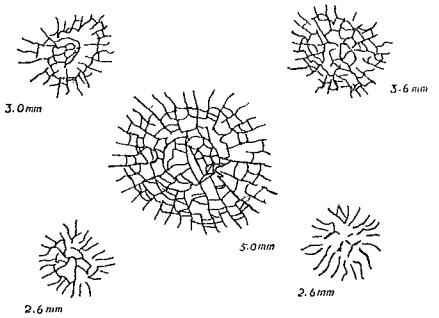
Text-figure 39

Waagenophyllum (*Waagenophyllum*) *virgalense* (WAAGEN et WENTZEL) (×3.3) Iwaizaki, Kesennuma city, Miyagi Prefecture. *Neoschwagerina* zone. UHR 15523

and minor septa.

Incidentally, the stereozone encircling the wall is very thick in the Mongolian specimens, and the septa appear to be also very thick, especially near the wall, so that the interspace may become extraordinally narrow and may represent a narrow black line which may have been perhaps misunderstood by GRABAU to be tertiary septa. If, this supposition is correct, the Mongolian specimens may be also referable to *virgalense*.

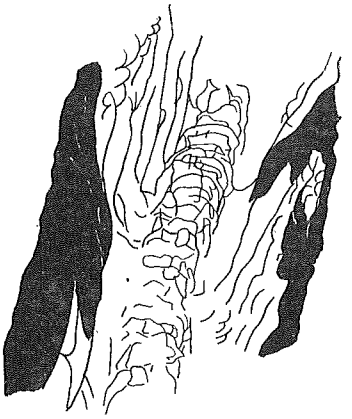
A Burmese coral described and figured by DIENER (1911) as belonging to *Lonsdaleia indica* is undoubtedly closely related to a form from the Jisu Honguer limestone, *mongoliense* which is in our opinion synonymous with *virgalense*. The specimen is quite noteworthy because of its occurrence together with "*Fusulina elongata*", a *Polydiexodina*. DIENER correlated *Fusulina* limestone of Shan states yielding these fossils at Kahsi Mansam with middle Productus limestone of the Salt



Text-figure 40

Showing the change in the mode of axial structure through ontogeny, *Waagenophyllum* (*Waagenophyllum*) *virgalense* (WAAGEN et WENTZEL) Cross section. UHR 15522

Neoschwagerina zone. Iwaizaki, Kesennuma city, Miyagi Pref. (Number is referring calicular diameter in each corallite.)



Text-figure 41

Waagenophyllum (*Waagenophyllum*) *virgalense* (WAAGEN et WENTZEL) (×5.8) Kasamatsu, Yatsushiro-gun, Kumamoto Prefecture. *Yabeina* zone. No. 63288, IGPS

range, which is in turn correlated to the Jisu Honguer Limestone by LICHAREW (1961). All of these specimens above mentioned therefore came approximately from the same horizon, which may be correlated to *Neoschwagerina* zone.

MANSUY (1912 a, b) established two species of *Waagenophyllum* (then *Lithostrotion*) from Indo China. They are both slightly different from *virgalense*, and may be justifiably distinguished from the latter. MANSUY's *mixtum* and *jourdyi* provide a somewhat large corallites, numerous septa, narrow stereozone which is partially disappearing, and axial column being rather complicated in comparison to *virgalense*.

However, we have experienced through the observations on the Japanese materials, that *virgalense* show considerable variation in its internal characters. The length of the minor septa, the width of setereozone, corallite size and septal numbers, and the width and the complexity of axial column vary from one corallum to the other. Therefore there must have existed some transitional forms between *mixtum*, *jourdyi* and *virgalense*.

We tentatively take the specific content of *virgalense* rather broadly to include forms typical to *virgalense*, *mongoliense* as well as *mixtum* group.

Indo-Chinese forms seem to occur higher in horizon compared to *virgalense* in Salt range, though FONTAINE, who thoroughly restudied Indo-Chinese coral fauna, did not state their exact age beyond that they are Kunguro-Kazanian, thus *Neoschwagerina* to *Yabeina* zone.

Specimens in our repository: Reg. nos. 15522, 15523, 18207–18215 (Iwaizaki, Motoyoshi-gun, Miyagi Prefecture; *Neoschwagerina* zone) Nos. 15264, 15265 (Yamazaki, Maiya-machi, Tome-gun, Miyagi Prefecture; *Yabeina* zone)

Specimens in the Inst. Geol. and Palaeont., Tohoku Univ., Reg. nos. 63288, Hayamizu-Kasamatsu, Kawamata-mura, Yatsushiro-gun, Kumamoto Prefecture.

Waagenophyllum* (*Waagenophyllum*) *akasakense (YABE)

Pl. 6, figs. 1–8; Text-figs. 42, 48 ak.

1909 *Lonsdaleia akasakensis* YABE, p. 4–5, fig. 3.
1915 *Lonsdaleia* (*Waagenella*) *akasakensis*, YABE and HAYASAKA, p. 100–104.
Non *Waagenophyllum akasakensis*, OZAWA, 1925, p. 75, pl. 14, figs. 5, 6.
1930 *Waagenophyllum akasakensis*, SMITH, p. 36.
1955 *Waagenophyllum akasakensis*, MINATO (par), p. 104, pl. 37, fig. 7, (non figs. 6a–e).
1962 *Waagenophyllum* sp. B, YAMAGIWA, p. 96, pl. 8, fig. 3.

Lectotype: A specimen studied by YABE (1902), and is stored at the Inst. Geol. & Paleont, Tohoku Univ., Sendai.

Type locality: Kinshozan, Akasaka, Gifu Pref., Central Japan.

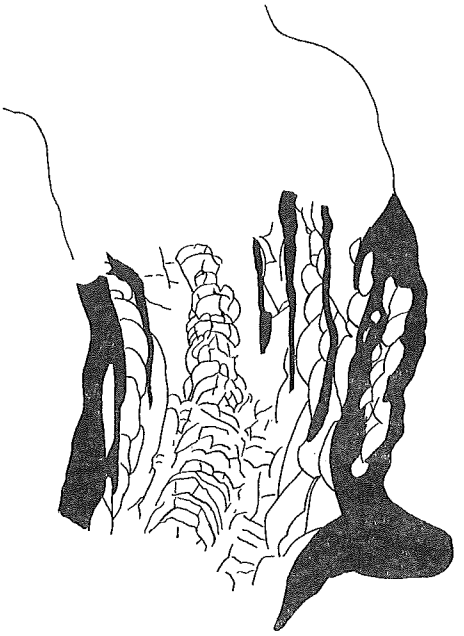
Geological horizon: *Yabeina globosa* zone.

Geographic distribution: Japan.

Specific diagnosis: *Waagenophyllum* with relatively large corallites, in which the axial structure does not occupy a wide area, but is rather loosely constructed. Septa are very thick, especially in the peripheral and medial area, although they become axially thin more of less. Minor septa are fairly long, generally longer than 2/3 the length of the major ones and usually reaching approximately 4/5 the length of the major septa. Clinotabulae and elongate dissepiments are well developed, the latter of which locally replaced the globose dissepiments in the entire peripheral zone. Globose dissepiments may also develop, but are very few, if any.

Remarks: The present species seems to be akin to the type species of the genus *Waagenophyllum* in having well developed clinotabulae and elongate dissepiments against rather ill developed globose dissepiments, but is specifically separable from the latter in size of corallites and septal number. Further, the present species possesses far thicker septa, and the minor septa are long. In the lectotype speci-

men, here newly designated, which was first described by H. YABE and now stored at the Geological and Palaeont. Inst. Tohoku University, Sendai possesses corallites with very thick major and minor septa. All of the septa are so thick that they are completely joined with each other in the cross section. Especially they are very thick in the peripheral and medial area, although they become distally thinner in the central area. Needless to say, tertiary septa are totally absent.



Text-figure 42

Waagenophyllum (*Waagenophyllum*) *akasakense* (YABE) (×5.4); Akasaka, Gifu Prefecture. *Yabeina* zone. UHR 18191.

The present form appears to resemble *Waagenophyllum virgalense* to some extent, but is distinct from the latter in having greater corallites and longer minor septa, compared to *virgalense*.

By the rather loosely constructed axial structure, the present species is also easily distinguishable from *Waagenophyllum compactum* sp. nov., which will be described later. Also, from the different thickness of septa, the present form may be specifically distinct from *Waagenophyllum pulchrum* HAMADA at least in the mature stage. This will also be described later in detail. In this regard, the specimens once described by OZAWA as *Waagenophyllum akasakensis* must be regarded as *W. pulchrum*, instead of *akasakense*. As a matter of fact, the specimen has corallites with decidedly thinner septa in the mature stage.

Specimens in our repository, Reg. nos. 15539, 15541–15542, 15544–15545, 15550, 16462–16463, 16475, 18189–18191.

Akasaka (*Yabeina* zone), Fuwa-gun, Gifu Prefecture.

Waagenephyllum (*Waagenophyllum*) *pulchrum* HAMADA

Pl. 4, figs. 1–2, Pl. 8; Text-figs. 43–45.

? 1886 *Lonsdaleia indica*, WAAGEN and WENTZEL, pl. 115, figs. 3, 4. (non pl. 101, figs. 1, 2, 3).
1925 *Waagenophyllum akasakensis*, OZAWA (non YABE) p. 75, pl. 14, figs. 5, 6.
1955 *Waagenophyllum akasakensis*, MINATO (non YABE), p. 104, pl. 37, figs. 6a–3, non 7.
? 1960 *Waagenophyllum* cf. *akasakensis*, YOKOYAMA (non YABE), p. 242, pl. 28, figs. 1, 2.
? 1960 *Waagenophyllum* sp. YOKOYAMA, p. 243, pl. 27, fig. 6; pl. 28,
? 1962 *Waagenophyllum* sp. *A*. YAMAGIWA, p. 95–96, pl. 8, fig. 4.
1962 *Waagenophyllum pulchrum* HAMADA, in MAEDA and HAMADA, p. 7, pl. 1, figs. 1, 2; pl. 2, figs. 1; pl. 3, figs. 1–3; pl. 4, figs. 1–5.

Holotype: Reg. no. 6206, Geol. Inst. College of Arts and Sciences, Chiba University, Chiba.
Type locality: Takagami quarry in Chosi, Chiba Prefecture, Japan.
Geological horizon: *Neoschwagerina* to *Yabeina* zone.
Geographic distribution: Japan and Pakistan.

Specific diagnosis: *Waagenophyllum* with a thin wall. Axial structure occupies a rather narrow area, in which a distinct median plate is only rarely observable. Clinotabulae are highly developed. Elongate dissepiments, large and small, are also well developed, which locally replace globose dissepiments, up to the outer margin of peripheral area. However, in most parts of the corallite, globose dissepiments are also fairly well developed, and are arranged in two or three rows. In the early stage, septa of this species are fairly thick and it appears to strongly resemble *Waagenophyllum akasakense* (YABE).

Description: Corallum fasciculate and phaceloid. Corallites irregularly spaced with each other, sometimes widely apart, while in other cases they are in contact.

Corallites are rather small, and the calicular diameter is less than 6.2 mm at its maximum, so far as the observed corallites are concerned. Twenty four major septa were counted, alternating with the same number of minor septa. Tertiary septa are lacking. Septa are thick at the wall and are thin distally, without any remarkable deposits throughout their growth. Minor septa slightly thinner and shorter than the major ones; generally reaching 3/4 the length of the latter in the full grown stage.

Both major and minor septa are mostly diffusotrabecular and partly semitrabecular from a view point of minor structure, in which the translucent layer is only poorly retained.

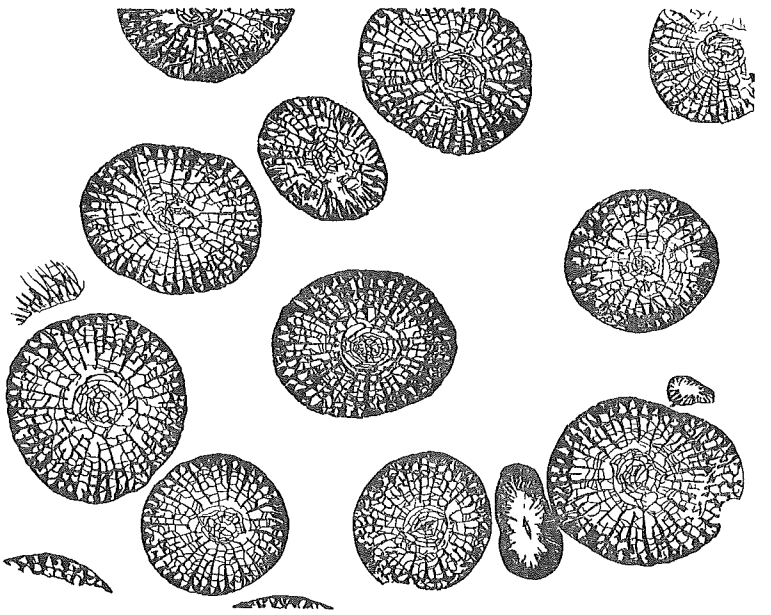
The axial structure generally occupies a rather narrow area, and the diameter

in the para-longitudinal section is always a little longer than the ortho-longitudinal one. For instance, the diameter of axial column is 1.4 mm in the para-longitudinal section, and 1.2 mm in the ortho-longitudinal one in the corallite whose calicular diameter is approximately 5.2 mm.

The median plate is usually very short, if observed, and a distinct median plate is generally discerniable in most corallites. Therefore, no septa directly unite with the median plate, if the counter septum is long enough to connect the columella. Cardinal septum nearly always does not join with the axial structure. Septal lamellae are only poorly developed in most corallites, which do not directly unite with any septa and are also not directly prolonged to the axis of corallite but often interrupt their growth at certain tabulale. The edges of the axial tabellae seem to be rather straight in the cross section; the outermost of them are however curved, in facing their concavity inwards in the cross section.

Clinotabulae together with elongate dissepiments are easily distinguishable from globose dissepiments in the cross section, the latter of which are angulo-concentric in arrangement, whose cut edges are a little curved, against the straight line of the clinotabulae and elongate dissepiments in the cross section.

In the longitudinal section, globose dissepiments occupy the outer zone of



Text-figure 43

Waagenophyllum (*Waagenophyllum*) *pulchrum* HAMADA (×3.6); Takagami quarry, Chohshi city, Chiba Prefecture. *Yabeina* zone. UHR 18193

Text-figure 44
Waagenophyllum (*Waagenophyllum*) *pulchrum* HAMADA (×3.3).
Takagami quarry, Chohshi city, Chiba Prefecture.
Yabeina zone. UHR 18194

Text-figure 45
Waagenophyllum (*Waagenophyllum*) *pulchrum* HAMADA (×2.7) Shiraiwa, Miné city, Yamaguchi Prefecture. *Yabeina* zone. III 45, OZAWA collection, Tokyo Univ.

the corallite, obliquely arranged in more than two rows. Some of them are rather elongate and face their convex sides inwards, and are apt to be misunderstood for

small elongate dissepiments. Nevertheless, the elongate dissepiments are larger and more elongated than the globose dissepiments, and they generally occupy the area more inner zone of corallite than the latter. Yet, there is a case in which the peripheral part of corallite is locally occupied by only elongate dissepiments, large and small, and completely replace the globose dissepiments.

The tabularium occupied by clinotabulae is as wide as the dissepimental zone. Transverse tabulae are less developed in most corallites, they are lacking or only sporadically developed, if any. Further, the transverse tabulae are very short and almost horizontal.

The axial structure is composed of sinuous and often discontinuous median plate and numerous, and irregularly inclined tabellae, in which no continuous long septal lamellae are, however observable. In some part of corallite, the tabellae are highly cystose and steeply incline to form a tent like structure as a whole, while in others they are rather smoothly uparching to form an inverted cup in cup structure.

Remarks: The present coral occasionally shows lateral increase, in which offsets always arise horizontally from protocorallite. The early stage of new offset is somewhat resembled connecting tubule, but the presence of connecting process cannot be observed in the corallites we treated.

As a matter of fact, we studied this coral and knew it to be a new species, prior to the report made by HAMADA. Our specimens were collected by Dr. Y. HASEGAWA from the same locality as the type outcrop of this species.

HAMADA already fairly well described this coral, however, he paid little attention on the prominent development of clinotabulae in this coral, the presence of which should be emphasized in our opinion. Further, HAMADA described the septa of the present form to be monacanthine in structure, but this is not correct at all.

The present species has a rather narrow axial column (which can be definitly observed in the longitudinal section), and rather numerous globose dissepiments. Accordingly, we are of the opinion that this species may show a rather primitive nature as a whole among *Waagenophyllum*, in spite of strong developments of clinotabulae and fairly well developed elongate dissepiments.

At the type locality, the horizon of this coral is hardly known, although it may associate with *Yabeina* or *Lepidolina*. This coral was found in a limestone pebble included in the formation of an unknown age.

Meanwhile, the coral illustrated by WAAGEN and WENTZEL of figs. 3 and 4 of plate 101 from the Middle Productus limestone of the Salt range under the name of *Lonsdaleia indica* has thick septa in the early ontogenic stage and many globose dissepiments and may accordingly be conspecific with the Japanese species now in question. It may however be a possibly different species from the type species of the genus *Waagenophyllum*. Hence, the geological age of this coral

seems to range from the *Neoschwagerina* zone up to the *Yabeina* zone.

Also, the specimens once described by OZAWA from the Akiyoshi limestone plateau under the name of *Waagenophyllum akasakensis* is definitely conspecific with the present form. Although the senior author once agreed OZAWA in its specific identification, now he has become aware of the fact that the Akiyoshi form has decidedly thin septa in the ephebic stage, though fairly thick in the early stage, besides the minor septa of the Akiyoshi specimens are far shorter than the typical form of *akasakense*.

Lastly, the early stage of the present coral is worthy of note. All of the corallites observed in the early stage, have rather thick septa. They are generally united with each other, so that in the peripheral and medial area no dissepiments of any type can be observed in the cross section.

In addition, local replacement of elongate dissepiments by globose ones is quite characteristic. All such features strongly remind us of *Waagenophyllum akasakense* (YABE). Some corallites especially in the early stage, illustrated by HAMADA for instance show a strong resemblance to that of YABE's species, although the ephebic stage of the present form is obviously distinct from the latter in the thickness of septa.

Specimens in our repository: Reg. nos. 15528, 15535, 15538, 15543, 15546, 15548, 15549, Akasaka, Fuwa-gun, Gifu Prefecture (*Yabeina* zone); Reg. nos. 18192–18194, Takagami guarry in Choshi City, Chiba Prefecture; Reg. nos. 18163–18170, Shiraiwa, Omine-mura, Akiyoshi, Yamaguchi Prefecture (*Yabeina* zone).

***Waagenophyllum* (*Waagenophyllum*) *compactum*,** ap. nov.

Text-fig. 46.

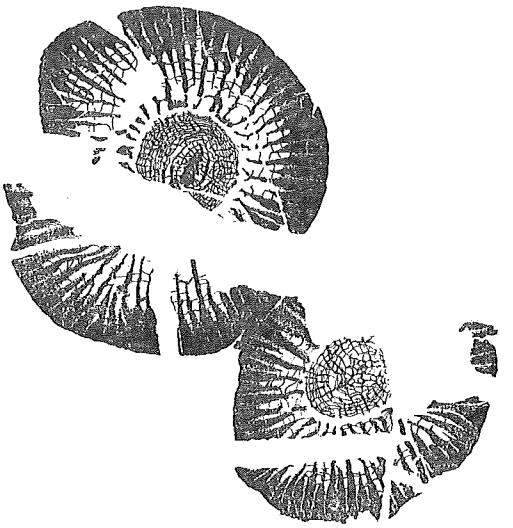
1960 *Waagenophyllum longiseptatum* YOKOYAMA (non TSENG), p. 241, pl. 28, figs. 3a-e.
Holotype: U. H. R. 18206, Paratype: 18205. 17894.
Type locality: Kinsho-zan, Akasaka, Gifu Pref., Central Japan.
Geological holizon: *Yabeina* zone.

Specific diagnosis: *Waagenophyllum* with thick septa in the peripheral and medial zone. Minor septa are fairly long. The columella is densely and regularly constructed; the median plate is however rather indistinct.

Description is now based on only three cross sections, which are available for the present species. The corals were collected at Akasaka by the late Dr. T. NAGAO from possibly the *Yabeina* limestone.

Corallum fasciculate. Septa are very thick and almost completely in contact or only a little apart from each other in the peripheral and medial area, although they become gradually thin towards the distal end. Septa are of typical diffuso-

trabecular type. Major septa are generally long but do not directly unite with septal lamellae of the axial column. Minor septa are in general more than 1/2 the length of the major ones, and reach almost 3/4 to 5/6 the length of the latter in the full grown stage.



Text-figure 46

Waagenophyllum (*Waagenophyllum*) *compactum* MINATO et KATO, sp. nov. (×3.8). Akasaka, Gifu Prefecture. *Yabeina* zone. UHR 18206

Major septa alternating with minor septa were counted 31 in the corallites in which the calicular diameter is 12 mm.

The axial column is always quite compact, and occupies a rather broad area. It is always regularly constructed by densely arranged axial tabellae and radially disposed numerous septal lamellae in the cross section. The median plate is generally indistinct, and it is short, if any.

Remarks: Although no longitudinal sections for the present species are available, the cross section reveals to be quite new to us. At first, the present form appears somewhat allied to *Waagenophyllum smithi*, which will be described later in detail. However, the axial column of the present form occupies a rather wide area. In addition, the median plate is frequently indistinct in the column. Further, the nature of septa of the present species remarkablly differs from that of the latter as will be later described in detail.

Now, the coral described by YOKOYAMA from the Permian of Taishaku, under

the name of *Waagenophyllum longiseptata* seems to be closely allied or rather conspecific with the present form now in question.

YOKOYAMA's coral seems to have apparently smaller axial column, than one of the largest corallites of the holotype of the present species. Yet, in the longitudinal section illustrated by YOKOYAMA in 3c on plate 28, YOKOYAMA's coral has a rather large axial column, with a diameter approximately 1/3 the length of the calicular diameter, although it may be the para-longitudinal section.

Further, the present form seems to vary considerably in size of axial column in each corallite. It is not always as large as the typical form. Hence, the size of axial column cannot be the condition to specifically distinguish the present form from YOKOYAMA's specimens.

In our opinion YOKOYAMA's coral is closely identical with the present form in dilatation of septa, length of minor septa, construction of axial column, and weak development of median plate. Thus, YOKOYAMA's coral is now concluded to be entirely conspecific with the present form, now in question.

The name of *Waagenophyllum longiseptatum* has already been used by TSENG in 1949. The new name *compactum* is accordingly proposed for the present species, in designating newly the specimens stored at our department as the holotype.

Distribution: Akasaka and Taishaku districts, Central and Southwest Japan respectively. Both in the *Yabeina* zone.

Waagenophyllum* (*Waagenophyllum*) *smithi nov.

1926 Coral gen. et sp. nov., SMITH and RYDER, p. 157, pl. 6, figs. 1, 2.
1935 *Waagenophyllum indicum*, SMITH (non WAAGEN et WENTZEL), p. 34, pl. 8, figs. 1–6.
Holotype: R. 6589, British Museum (KOKEN coll.)
Type locality: Middle Productus limestone, upper zone, Virgal, Salt Range, Punjab, Pakistan.
Geological horizon: *Neoschwagerina* zone.

Specific diagnosis: *Waagenophyllum* with thin stereozone in the peripheral area. Axial structure is constructed as compact as *Waagenophyllum compactum* nov., but the present form always possesses distinct median plate, besides axial tabellae and septal lamellae. Further, septa are rather thin in the medial and axial area. Minor septa are short.

Remarks: SMITH and RYDER already well described the present coral (R. 22380, British Museum) in 1926, however they did not propose a name, because the material was unknown regarding its locality and age. The description of the label attached to the specimen, indicating that the coral was found somewhere near Bristol, is unreliable, according to them.

Later, SMITH placed the coral into *Waagenophyllum indicum* in 1936, together with the corals then newly collected from the Middle Productus limestone of the Salt range. However, all such forms reported by him may neither belong to *Waagenophyllum indicum*, nor *virgalense*. Since, all of them definitly possess a more compact axial column in which the median plate is nearly always clearly observable in the cross section.

The present form merely resembles *W. virgalense*, because of the presence of a definite stereozone in the peripheral area, and quite well developed clinotabulae and elongated dissepiments. Globose dissepiments are hardly recongizable in the corallites in the longitudinal section, presented by SMITH. Nevertheless, the specific distinction between them is quite obvious from the above view point.

The present form may be somewhat allied to *Waagenophyllum compactum* nov., in having a sterozone and compact axial structure.

However, the present form possesses slightly smaller corallites in general (calicular diameter ranging from 4 to 6 mm) than the latter (calicular diameter 7 to 12 mm), although it cannot be viewed to be sufficent criterion for specific distinction. Further, the present form almost always possesses a distinct median plate in the axial column, which is rather long and occasionally thick, although the same plate is not absolutely lacking in *Waagenophyllum compactum*.

The most remarkable difference between the two, seems to be in the different nature of septa. In the present form septa are rather thin in the medial and axial area, whereas the septa of *W. compactum* are strongly thick even in the medial area. Further, the present form has decidedly shorter minor septa than the latter.

Waagenophyllum* (*Waagenophyllum*) *novaezelandiae LEED

Text-fig. 47–2.

1956 *Waagenophyllum novaezelandiae* LEED, p. 16, pls. 3 and 4.
1962 *Waagenophyllum novaezelandiae japonicum* YAMAGIWA, p. 95, pl. 7, figs. 4–6.
Specific diagnosis: Large *Waagenophyllum* with large axial coumn and a large number of elongate dissepiments.
Holotype: New Zealand Geol. Surv., corallum, CO 1261, slides C 1000, 1004, British Museum (Natural History) slides R. 39606, 39607, 39608.
Geologic horizon: According to a communicaion from Prof. D. HILL, it is *Yabeina* zone.
Type locality: GS 5074, Marble bay, east of Tauranga bay, Wangarosa (Grid reference N8/301838).

Remarks: This coral is very characteristic in the following three points, viz. (1) in having large corallites, whose dismeter reaches as long as 14 mm, (2) in possessing large axial column, the diameter of which is somewhat the 1/2 length of that of

corallite, and (3) in bearing dissepimentarium nearly entirely composed of large elongate dissepiments. According to LEED, globose dissepiments may also present at periphery in this coral, although the peripheral part of the specimen was unfortunately not well shown by LEED at least in the longitudinal section. In all probability, we suppose, however, that such globose dissepiments may be extremely few, if any.

So far as the figured specimen in the longitudinal section is concerned, the existence of globose dissepiments is not certain. In the corss section, there is a fairly thick stereozone along the wall, instead of a dissepimental zone.

The coral placed by YAMAGIWA into the subspecies of the present form may be in reality almost not separable from the latter in specific or subspecific rank. YAMAGIWA described the difference in the axial structure. As to the size of the axial structure, we, however, cannot recognize any remarkable difference between them, when the corallites in mature stage are compared with each other. As for the axial structure, there is a rather strong similarity. Thus the specific identification is beyond doubt.

YAMAGIWA described that his specimens were found in the limestone representing the lower part of his "*Huangia*" *akagoensis* and "*Waagenpohyllum*" *nogamie* zone. If it is true, the present form must be considered to range from the far lower part of the Permian up to the *Yabeina* zone.

Subgenus ***Chaoiphyllum*** nov.

Type species: *Waagenophyllum* (*Chaoiphyllum*) *chaoi*, sp. nov.

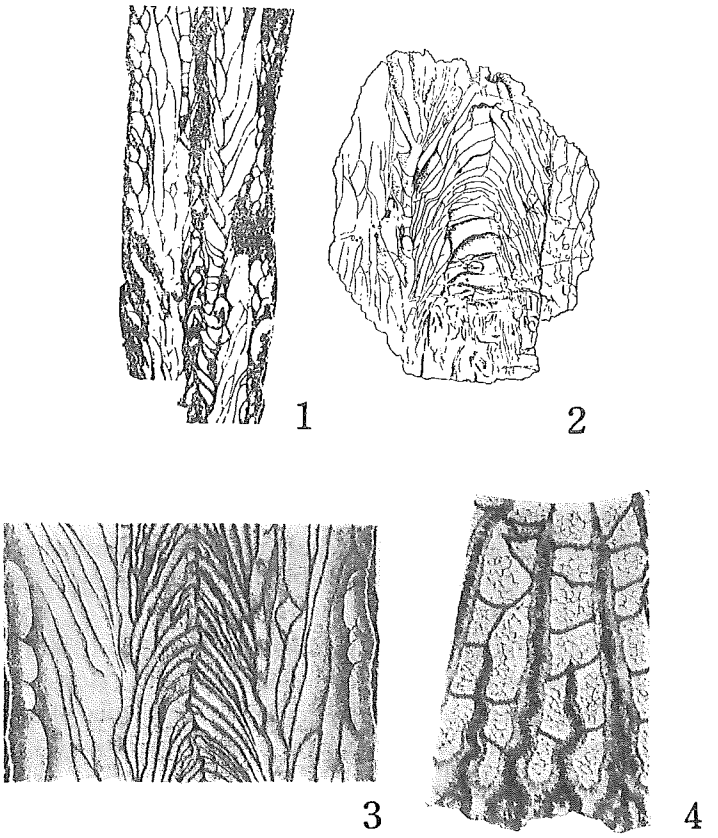
Subgeneric diagnosis: Fasciculate Waagenophyllidae with very loosely constructed or diphyphylloid axial structure. Minor septa are fairly long, approximately 2/3 the length of the major ones. Septa are thin. Globose dissepiments are well developed, which are locally lonsdaleoid near the wall in the cross section. Clinotabulae and large elongate dissepiments are well developed.

Waagenophyllum (***Chaoiphyllum***) ***chaoi***, sp. nov.

1932 Unnamed coral, gen. et sp. indet, HUANG, pl. 16, figs. 9a, b.
Holotype: No. 3948, Geol. Surv. China.
Locality: Gnomeishan, Szechuan, coll. Y. T. Chao, loc. no. 1434.
Horizon: *Pseudofusulina-Parafusulina* zone.

Specific diagnosis is outlined in the subgeneric diagnosis.

Remarks: The corallite of the present species seems to be approximately 6 mm



Text-figure 47

Reproduced figures.

1 : *Waagenophyllum* (*Waagenophyllum*) *kueichowense* HUANG. Longitudinal section (after HUDSON, 1958). Showing narrow axial column, rather irregular globose dissepiments, elongate dissepiments, clinotabulae and narrow transverse tabulae.

2 : *Waagenophyllum* (*Waagenophyllum*) *novaezelandiae* LEED. Longitudinal section (after LEED, 1956). Showing broad axial column and very narrow transverse tabulae.

3 : *Waagenophyllum* (*Waagenophyllum*) *indicum* (WAAGEN et WENTZEL) Longitudinal section (after WAAGEN & WENTZEL, 1886). Showing narrow globose dissepiments, elongate dissepiments, clinotabulae, extremely narrow transverse tabulae, and axial column in regular cone in cone type.

4 : *Waagenophyllum* (*Waagenophyllum*) *indicum* (WAAGEN et WENTZEL) Transverse section (after WAAGEN & WENTZEL, 1886). Showing fine structure of septa.

(As to fine skeletal structure of some waagenophyllids the readers are referred to KATO, 1963).

in its calicular diameter of the full grown stage, in which septa of two orders number up to as many as 44 in all. The major septa numbered 22 and alternate with the same number of minor ones which are very long, reaching almost always the axial area, while the latter are generally 2/3 the length of the former. Septa are decidedly thin. The very narrow area near the wall is locally free from septa, where the dissepiments become lonsdaleoid, although the existence of large lonsdaleoid dissepiments is hardly observable anywhere.

Unfortunately, the longitudinal section illustrated by HUANG is not centrally cut, and may even be partly tangential and at the same time partly oblique. Accordingly, the nature of axial area of the present species cannot be sufficiently known from the illustration of the longitudinal section given by HUANG. In any case, the transverse tabulae of the present species are, however very narrow as in all of the species belonging to the genus *Waagenophyllum* s. str.

Further, the axial structure also occupies a very narrow space, if any, which may be possibly very loosely constructed by a few concentric axial tabellae and a few irregularly disposed septal lamellae in the cross section. Also the axial structure may sometimes show a diphyphylloid trend on the way of ontogenetical course.

Thus, the present form is now concluded to be rather strongly deviated from *Waagenophyllum* s. str.

The existence of lonsdaleoid dissepiment seems to suggest the present form to be somewhat comparable to *Huangia* or *Akagophyllum*. However, this may be only a superficial observation, because of the highly developed clinotabulae and elongated dissepiments in the present species, even if we ignore the nature of axial structure of the present species for a while. Further, it may also be remarkable that the present species possesses narrow transverse tabulae.

In all probability, the present species may be more allied to the species of *Waagenophyllum* with a very narrow and loosely constructed axial column, *Waagenophyllum kueichowense* HUANG or *Waagenophyllum huangi* DOUGLAS for instance. Possibly, the present form may be regarded to be a more primitive form than the two species above described, since the former is characterized by the presence of a more narrower and loosely constructed axial column than the latter.

When the hitherto known species belonging to the genus *Waagenophyllum* s. str. are reviewed, it will be noted that the more primitive or relatively earlier forms have a simple or loosely constructed axial structure which merely occupies a narrow space as compared against the more progressive or later forms having a more complex and wide axial structure, as will be later stated in detail. Likewise, the globose dissepiments are more abundantly found in the earlier forms than in the later forms.

In this connection, the present species may be the most primitive form of *Waagenophyllum*, or even the forerunner of the genus *Waagenophyllum* s. str.

With respect to the presence of lonsdaleoid dissepiments in the present species,

it may also be interpreted as a sign which may indicate that the present form is the most primitive form of *Waagenophyllum*, since in the fasciculate Waagenophyllidae, lonsdaleoid dissepiments are definitly concluded to be in a retrogressive trend in their phylogeny.

In any event, the present form possesses rather narrow transverse tabulae, and this feature shows the present subgenus to be fairly deviated from *Liangshanophyllum* or *Huayunophyllum* as compared to *Waagenophyllum* (*Waagenophyllum*).

As to the geological horizon of this Chinese coral, we do not know exactly, but it may be perhaps Chihsian, the *Pseudofusulina* zone, judging from other fossils, recorded from the Gnomeishan.

Subgenus ***Liangshanophyllum*** TSENG, 1949

Type species: *Waagenophyllum* (*Liangshanophyllum*) *lui* TSENG, 1949.

Synonymy:

1949 *Waagenophyllum* (*Liangshanophyllum*) TSENG, p. 100.
1955 *Waagenophyllum* (*Liangshanophyllum*), WANG, YÜ and YOH, p. 42
1957 *Waagenophyllum* (*Liangshanophyllum*), WU, p. 329
1961 *Waagenophyllum* (*Liangshanophyllum*), FONTAINE, p. 170
1962 *Liangshanophyllum* YÜ, pp. 6–7.
Non *Huangia* YABE, 1950.
Non *Liangshanophyllum*, IGO, 1961.

Subgeneric diagnosis: Fasciculate Waagenophyllidae closely resembles *Waagenophyllum* (*Waagenophyllum*), but provides broader, sub-horizontal transverse tabulae, besides sporadically distributed, inclined clinotabulae. Elongate dissepiments of large and small size are well developing. The axial column is simply constructed, in which the median plate is, however, always prominent.

Geologic distribution: *Palaeofusulina-Richthofenia* zone of Lopingian in China (= *Yabeina* zone).
Geographic distribution: China.

Included species:

Waagenophyllum (*Liangshanophyllum*) *lui* TSENG, 1949.
Waagenophyllum (*Liangshanophyllum*) *streroseptatum* TSENG, 1949
Waagenophyllum (*Liangshanophyllum*) *wui*, nov.
Waagenophyllum (*Liangshanophyllum*) *sinense* WU, 1957.

Remarks: The present subgenus has been variously interpreted by workers. However we would rather restrict it within a branch of *Waagenophyllum*. TSENG originally included cerioid forms in his subgenus, although he did not describe

forms corresponding to his concept at that time. FONTAINE raised the subgenus to generic rank, retaining the genus to include cerioid forms.

We do not see any necessity to have two different growth forms within a genus in this case, but feel it necessary to restrict this subgenus to a mere branch of *Waagenophyllum*, a fasciculate genus.

Incidentally the statement given by TSENG that the subgenus is provided with tertiary septa is apparently erroneous.

At a glance the subgenus well coincides with *Waagenophyllum* s. str., but is distinguishable from the latter in having a broad zone of transverse tabulae, and a rather narrower axial column.

The American genus *Heritschiella* is similar to *Liangshanophyllum* but is separable from it in that it provides a broader dissepimentarium, numerous septa and a densely constructed axial column as compared to the latter.

Liangshanophyllum has a very close morphology to *Pseudohuangia*, but still it is distinguishable from the latter by the essential possession of elongate dissepiments of the former. In addition, corallites of *Pseudohuangia* are in general larger than those of *Liangshanophyllum*, and clinotabulae of the former are less steeply inclined compared to those of the latter.

Genus *Huangia* has often been confused with *Liangshanophyllum*, but the distinction between the two is quite clear. In *Huangia* minor septa are not well developed, and lonsdaleoid dissepiments are observed to occur.

Waagenophyllum* (*Liangshanophyllum*) *sinense WU

1957 *Waagenophyllum* (*Liangshanophyllum*) *sinense* WU, p. 337, pl. 2, figs. 1, 2.
Holotype: Cat. nos. 8827, 8828, Inst. Palaont. Acad. Sinica.
Type locality: Middle part of the Wuchiaping limestone about 3 km SE of Yen-erh-wuliangshan, S. Shensi.
Geological horizon: The coral was found in association with *Codonofusiella*, *Reichelina* etc. Hence the age may be correlatable with the *Yabeina* zone in rough estimation.

Waagenophyllum* (*Liangshanophyllum*) *lui TSENG

1949 *Waagenophyllum* (*Liangshanophyllum*) *lui* TSENG, p. 101, pl. 1, figs. 2a, b.
Holotype: Cat. no. 6948.
Type locality: Liangshan, Southern Shensi, China.
Geological horizon: Wuchiaping limestone (= *Palaeofusulina-Reichelina* zone).

Waagenophyllum (*Liangshanophyllum*) *stereoseptatum* TSENG

1949 *Waagenophyllum* (*Liangshanophyllum*) *stereoseptatum* TSENG, p. 102, pl. 1, figs. 3a, b.
Holotype: Cat. no. 6949.
Type locality: p. 32–1, Liangshan, Southern Shensi, China.
Geological horizon: Wuchiaping limestone, Loping series (= *Palaeofusulina-Reichelina* zone).

Waagenophyllum (*Liangshanophyllum*) *wui* sp. nov.

1949 *Waagenophyllum* (*Liangshanophyllum*) *wengchengense*, TSENG, p. 103, pl. 1, figs. 1a–b.
1955 *Waagenophyllum* (*Liangshanophyllum*) *wengchengense*, WANG, YÜ & YOH, p. 42, pl. 17, figs. 3, 4.
Non *Waagenophyllum wengchengense*, HUANG, 1932.
Non *Waagenophyllum* (*Liangshanophyllum*) *wengchengense*, WU, 1957.
Holotype: Cat. no. 6950.
Type locality: P-7, Liangshan, Southern Shensi, China.
Geological horizon: Wuchiaping limestone, Loping series (= *Palaeofusulina-Reichelina* zone).

Description: Corallum compound, fasciculate. Corallites are round or somewhat quadrate in outline in the cross section. Setpa are in two oders, both of which are comparatively long. The axial column is stout and small, and occupies only one fourth to one fifth of the diameter of corallites. Inner wall indistinct.
Remarks: TSENG ascribed this form to be *Waagenophyllum wengchengense*. However the cross section of TSENG's forms does not appear to be identical with HUANG's *wengchengense*. The former shows a narrow axial column and small corallites in comparison to the latter. WU once described *Liangshanophyllum wengchengense*, and his form is rather comparable to HUANG's form. We consider that *wengchengense* HUANG is rather close to *Waagenophyllum*, and is not conspecific with TSENG's form, for which a new specific name, *Liangshanophyllum wui* is here proposed. This new form is distinguishable, as the specific diagnosis states, from the other three species of *Liangshanophyllum*, in having a small axial column and no inner wall. Besides, the dissepiments of this new species seem to be arranged in two rows, while they are normally in only one row in the other three.

Subgenus ***Huayunophyllum*** TSENG, 1959

Type species: *Huayunophyllum aequitabulatum* TSENG, 1959.
1959 *Huayunophyllum* TSENG, p. 500.

Diagnosis of the subgenus: Fasciculate waagenophyllids provided with small corallites, in which axial structure is very simply constructed, occupying a very narrow space. Dissepimentarium is composed of large and small sized elongate dissepiments, while globose dissepiments may only be poorly developed, if any. Lonsdaleoid dissepiments are absent. No tertiary septa are seen.
Included species:

Waagenophyllum (*Huayunophyllum*) *aequitabulatum* TSENG, 1959.
Waagenophyllum (*Huayunophyllum*) *teratoideum* (FONTAINE), 1961.
Waagenophyllum (*Huayunophyllum*) *kanense* (KAWANO), 1959.

Geologic distribution: *Neoschwagerina*?—*Palaeofusulina*, *Yabeina* zone.
Geographic distribution: China, Cambodge and Japan.

Remarks: Although TSENG especially placed stress on the importance of the dendritic corallum in this subgenus, the character merely has no more than a specific value in our view. The so-called regenerated feature in axial structure and high occurrence in geologic column of the present sub-genus render a justification to separate the present sub-genus from allied forms such as *Waagenophyllum* or *Liangshanophyllum*.

The chief difference between the present subgenus and *Liangshanophyllum* lies in the quite simply constructed axial structure of the former, although both of them are quite common in having rather broad transverse tabulae and highly developing elongate dissepiments.

Waagenophyllum (***Huayunophyllum***) ***aequitabulatum*** TSENG

1959 *Huayunophyllum aequitabulatum* TSENG, p. 499, fig. 1a–c in p. 501.
Syntype: fS 42–15a. Research Inst. Petroleum Science, China.
Type locality: Huayunshan, Szechuan, China.
Geologic horizon: Middle Chuang-ch'ang-wan formation, Loping series, *Yabeina* zone.

Remarks: The longitudinal section illustrated by TSENG as fig. 1c on page 501 is unfortunately not well orientated, the true nature of dissepimentarium of this corallite can be accordingly not fully understood.

However, TSENG stated as follows: " In dissepimentarium two outer rows

of dissepiments are small, curved upwards, 8–10 in 5 mm, while the inner two to three rows of dessepiments are narrower but larger than the outer ones. These two types of dissepiments are more easily marked off from the tabularium ".

Of the two types of dissepiments described by TSENG, the larger ones accordingly belong to the elongate dissepiments in our sense. In addition, there is also discerniable a long clinotabulae in the inner zone, which can partly be the inner, narrower and longer dissepiments designated by TSENG.

The problem lies on what are the so-called smaller dissepiments described by TSENG.

As a result of a careful observation of the illustrated figures, at least some of them can not be but globose dissepiments, but some inner ones could also be elongate dissepiments of small size. Also, some vesicles seem to represent cut edges of larger elongate dissepiments.

In any event, the illustrated corallite is not well oriented, and the matter is quite difficult to decide, as before stated. Nevertheless, we believe now, that the true globose dissepiments may thus rather few in the present species.

Waagenophyllum (*Huayunophyllum*) *teratoideum* (FONTAINE)

1961 *Waagenophyllum teratoideum* FONTAINE, p. 169, pl. 29, fig. 7; pl. 34, figs. 1–3.
Holotype: GUBLER collection no. 220, Sorbonne, Paris.
Type locality: A hill, Sway Chek road, Sisophon region, Cambodge.
Geologic age: *Yabeina* zone.

Remarks: FONTAINE did not illustrate any well orientated longitudinal sections. However, so far as the corallite illustrated in the middle part of fig. 2 on pl. 34 is concerned, clinotabulae and large sized elongate dissepiments including smaller ones are well developed in this species. Perhaps globose dissepiments may be rather few, if any.

In his figures 1 and 3, the corallites are obliquely or tangentially cut, yet there is no sign indicating that the globose dissepiments occupy a broad space in dissepimentarium.

Waagenophyllum (*Huayunophyllum*) *kanense* (KAWANO)

1959: *Huangia* ? *kanensis* KAWANO; p. 8, pl. 20, figs. 3–8.
Syntype: KAWANO, 1959, (pl. 20, figs. 3–8).
Type locality: Abu quarry, Izuto, Kane district, Ato-cho, Yamaguchi Prefecture.
Geological age: According to KAWANO, the present coral was found in association with *Neoschwagerina margaritae* (DEPRAT), *Parafusulina* sp, *Schwagerina* sp. etc. However,

he also stated that he found such older type coral as *Pseudopavona taisyakuana izutoensis* KAWANO, together with *Waagenophyllum* and others from the limestone cropping out at about 50m north of the Abu quarry, where he collected the coral, now in question.

The limestone cropping out at two localites above mentioned may according to KAWANO, belong to the same stratigraphical unit: viz. the Izuto limestone as it was designated by KAWANO.

If it is true, we cannot help but conclude that the older type of fossils are intermixed with the stratigraphically younger ones in this limestone. Namely, fossils of the *Neoschwagerina* zone seem to be intermixed for some reason with the Carboniferous type of coral. Hence, the age of the present coral has become an open question, and it cannot be easily concluded to be the Middle Permian as KAWANO once stated.

In the Yamaguchi region, there is a fairly widely distributed limestone conglomerate of the *Yabeina* age, which in general have the appearance of limestone itself at small outscrops, but contains limestone pebbles or breccias bearing fossils, which are quite various in origin regarding to their stratigraphical horizons. In all probability, the Izuto limestone may be such a case. Therefore, we tentatively estimate the age of the present coral to be the *Yabeina* zone. This view may also be supported by the fact that the other two species belonging to the subgenus *Huayunophyllum* denote the *Yabeina* zone.

Remarks: This is a very peculiar coral indeed. In the cross section, the skeleton of the coral is rather thickly constructed, and the general features of corallites are different from those of corals of Waagenophyllidae. Further, minor septa are short even in the ephebic stage, and the axial structure is loosely constructed, although it is strengthened by stereoplasmic deposits.

Nevertheless, the longitudinal section of the present coral reveals quite similar aspects to the genus *Huayunophyllum* in every detail.

KAWANO failed to give any good illustrations of corallites in longitudinal sections. Yet the corallites in his figures 3,5, and 8 prove the presence of large elongate dissepiments not only near the tabularium but also near the wall. This shows a probable lacking of common globose dissepiments in this species. At least, globose dissepiments may be extremely few, if any. This is also clearly indicated by the cross section of corallites, in which no globose dissepiments are found near the wall.

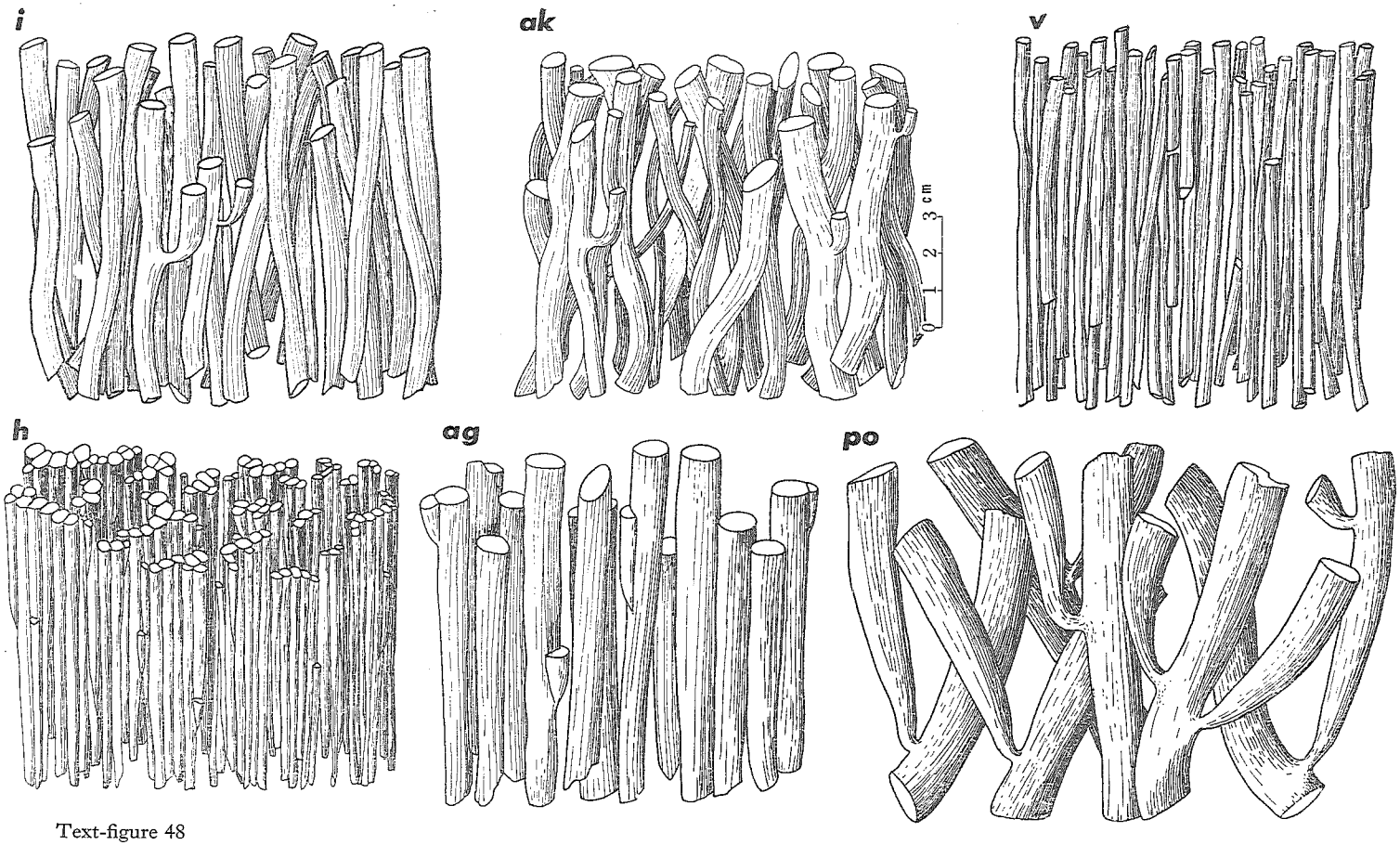
Further, it must also be mentioned that the corallites of the present form are rather small in general.

Thus, the present species can be placed into the genus *Huayunophyllum* with certainty.

The present species is specifically easily distinguishable from the two species mentioned in the foregoing pages in having rather thickly constructed corallites.

Check list of species once referred to *Waagenophyllum*

W. akagoense OZAWA, 1925 ..... *Akagophyllum akagoense* (OZAWA)



Text-figure 48

Reconstructed corallum shapes in some forms of Waagenophyllinae

i : *Waagenophyllum* (*Waagenophyllum*) *indicum* (WAAGEN et WENTZEL) ; ak : *W.* (*W.*) *akasakense* (YABE) ; v : *W.* (*W.*) *virgalense* (WAAGEN et WENTZEL)
h : *Akagophyllum hasegawai* MINATO et KATO ; ag : *A. akagoense* (OZAWA) ; po : *Waagenophyllum* (*Waagenophyllum*) *polyseptatum* MINATO

W. akasakense (YABE), 1902 ..... *Waageno.* (*Waageno.*) *akasakense* (YABE)
W. canaliferum (MANSUY), 1913 ..... *Parawentz.* (*Parawentz.*) *canalifera* (M.)
W. chitralicum SMITH, 1935 ..... *Pseudohuangia chitralica* (SMITH)
W. cinctum DOUGLAS, 1936 ..... *Pseudohuangia cincta* (DOUGLAS)
W. columbicum SMITH, 1935 ..... *Heritschioides columbicus* (SMITH)
W. crassiseptatum WU, 1957 ..... *Waageno.* (*Waageno.*) *indicum* (W. et W.)
W. frechi (VOLZ), 1904 ..... *Polythecalis frechi* (VOLZ)
W. gerthi OZAWA, 1925 ..... *Carinthiaphyllum* ? *gerthi* (OZAWA)
W. hupeiensis (YABE et HAYASAKA), 1915 .. *Yatzengia hupeiensis* (Y. et H.)
W. huangi DOUGLAS, 1950 ..... *Waageno.* (*Waageno.*) *huangi* DOUGLAS
W. indicum (WAAGEN et WENTZEL), 1886 *Waageno.* (*Waageno.*) *indicum* (W. et W.)
W. izuruhense SAKAGUCHI et YAMAGIWA, 1958
..... *Tanbaella izuruhensis* (S. et Y.) (M. S.)
W. japonicum YAMAGIWA, 1962 ..... *Waageno.* (*Waageno.*) *novaezelandiae* L.
W. jourdyi (MANSUY), 1912 ..... *Waageno.* (*Waageno.*) *virgalense* (W. et W.)
W. kueichowense HUANG, 1932 ..... *Waageno.* (*Waageno.*) *kueichowense* HUANG
W. longiseptatum TSENG, 1949 ..... *Waageno.* (*Waageno.*) ? *longiseptatum* T.
W. longiseptatum YOKOYAMA, 1960 .... *Waageno.* (*Waageno.*) *compactum* M. et K.
W. (*Liangshano.*) *lui* TSENG, 1949 ..... *Waageno.* (*Liangshano.*) *lui* TSENG
W. lui WU, 1957 ..... *Waageno.* (*Waageno.*) *simplex* WU
W. magnificum DOUGLAS, 1936 ..... *Praewentzelella magnifica* (DOUGLAS)
W. minimum DOUGLAS, 1950 ..... *Pseudohuangia minima* (DOUGLAS)
W. mixtum (MANSUY), 1922 ..... *Waageno.* (*Waageno.*) *virgalense* (W. et W.)
W. mongoliense GRABAU, 1931 ..... *Waageno.* (*Waageno.*) *virgalense* (W. et W.)
W. muricatum DOUGLAS, 1936 ..... *Pseudohuangia chitralica* (SMITH)
W. novaezelandiae LEED, 1956 ..... *Waageno.* (*Waageno.*) *novaezelandiae* L.
W. ochocoense MERRIAM, 1942 ..... *Heritschioides ochocoense* (MERRIAM)
W. omiense YABE et HAYASAKA, 1915 .... " *Corwenia* " *omiensis* (YABE et HAYASAKA)
W. persicum DOUGLAS, 1936 ..... *Pseudohuangia persica* (DOUGLAS)
W. polyseptata MINATO, 1955 ..... *Waageno.* (*Waageno.*) *polyseptatum* MINATO
W. pulchrum HAMADA, 1962 ..... *Waageno.* (*Waageno.*) *pulchrum* HAMADA
W.salinaria (WAAGEN et WENTZEL), 1886. . *Wentzelella* (*Wentzelella*) *salinaria* (W. et W.)
W. simplex WU, 1957 ..... *Waageno.* (*Waageno.*) *simplex* WU
W. (*Liangshano.*) *sinense* WU, 1957 ..... *Waageno.* (*Liangshano.*) *sinense* WU
W. (*Liangshano.*) *stereoseptatum* TSENG, 1949
..... *Waageno.* (*Liangshano.*) *stereoseptatum* T.
W. sublaeve (MEEK), 1864..... ?
W. tabellatum DOUGLAS, 1936 ..... *Pseudohuangia tabellata* (DOUGLAS)
W. tambense SAKAGUCHI et YAMAGIWA, 1963
..... *Waageno.* (*Waageno.*) *yunnanense* CHI
W. teratoideum FONTAINE, 1961 ..... *Waageno.* (*Huayuno.*) *teratoideum* (F.)
W. texanum HERITSCH, 1936 ..... *Verbeekiella* ? *texana* (HERITSCH)
W. tibeticum (REED), 1930 ..... *Akagophyllum tibeticum* (REED)
W. timoricum (GERTH), 1921 ..... *Ipciphyllum timoricum* (GERTH)

W. usuginuense MINATO, 1955 ..... *Waageno.* (*Waageno.*) *indicum* (W. et W.)
W. virgalense (WAAGEN et WENTZEL), 1886
..... *Waageno.* (*Waageno.*) *virgalense* (W. et W.)
W. washburni MERRIAM, 1942 ..... *Heritschioides washburni* (MERRIAM)
W. wengchengense HUANG, 1932 ..... *Waageno.* (*Waageno.*) *wengchengense* HUANG
W. wynnei (WAAGEN et WENTZEL), 1886 *Wentzelella* (*Wentzelella*) *wynnei* (W. et W.)
W. ? *yokoyamai* OZAWA, 1925 ..... *Yokoyamaella* (*Yokoyamaella*) *yokoyamai* (O.)
W. yunnanense CHI, 1938 ..... *Waageno.* (*Waageno.*) *yunnanense* CHI

(III. Massive forms)

Genus ***Yokoyamaella*** nov.

Type species: *Lonsdaleia* (? *Waagenophyllum*) *yokoyamai* OZAWA, 1925.

Derivation of generic name: OZAWA who first described the type species dedicated the specific name to his teacher, Prof. MATAJIRO YOKOYAMA, which became the generic name.

Generic diagnosis: Massive Waagenophyllidae with thick walls composed of mural septa first designated in this paper. Lonsdaleoid dissepiments may develop in various degrees. The septa are in two orders. The axial structure consists of solid columella in the early stage, which become lonsdaleoid in the mature stage. Clinotabulae and elongate dissepiments develop but are not typical.

Remarks: The newly proposed genus is easily distinguishable from *Wentzelella* in possessing thick walls composed of mural septa and different types of axial structure, although the other fundamental structures of corallites in the former considerably resemble that of the latter.

Further, the present genus has septa of two orders, while *Wentzelella* possesses tertiary or more orders of septa.

At present, three species have been correctly tabulated regarding their nature of longitudinal sections. So far as these species are concerned, the clinotabulae and elongate dissepiments are fairly well developed in the present genus, but they do not steeply incline as typical as in *Waagenophyllum*. Further, the transvers tabulae are remarkably horizontal, though not very broad.

Geological distribution: *Pseudoschwagerina* to *Yabeina* zone.
Geographic distribution: Japan, New Zealand, Yugoslavia and Carnic Alps.

Subgenus ***Yokoyamaella*** nov.

Type species: As for genus.

Diagnosis: Cerioid *Yokoyamaella* with thick mural septa.
Geologic distribution: *Pseudoschwagerina* to *Pseudofusulina* zone.
Geographic distribution: Carnic Alps, Yugoslavia and Japan.
Included species:

Yokoyamaella (*Yokoyamaella*) *yokoyamai* (OZAWA)
Yokoyamaella (*Yokoyamaella*) *stillei* (HERITSCH)
Yokoyamaella (*Yokoyamaella*) *tertioseptata* (YOKOYAMA)
Yokoyamaella (*Yokoyamaella*) *kurohime* sp. nov.
Yokoyamaella (*Yokoyamaella*) *carinthiaca* (HERITSCH)
Yokoyamaella (*Yokoyamaella*) *kaludjeracensis* sp. nov.

Yokoyamaella (***Yokoyamaella***) ***yokoyamai*** (OZAWA)

Pl. 1, figs. 1 & 6; Pl. 9, figs. 1–4; Text-figs. 5 f, 49–50.

1925 *Lonsdaleia* (? *Waagenophyllum*) *yokoyamai* OZAWA, p. 172, pl. 13, figs. 5, 6.
1933 *Lonsdaleia yokoyamai*, HERITSCH, listed only, p. 179.
Non 1936 *Lonsdaleia* (*Stylidophyllum*) cfr. *yokoyamai*, DOBROLYUBOVA, p. 53, pl. 81, figs. 91, 92.
1955 *Stylidophyllum yokoyamai*, MINATO, p. 134, pl. 41, fig. 2; pl. 43, fig. 5.
1962 *Stylidophyllum matsunagiense* YAMAGIWA, p. 90, pl. 4, figs. 1–3.
1962 *Wentzelella shimoyukawensis* YAMAGIWA, p. 92, pl. 6, figs. 3, 4.
Lectotype: The slides given by OZAWA in fig. 5 on his plate 13 is here designated as the lectotype, which are now stored at the Inst. Geol., Tokyo Univ. OZAWA Coll. III 64.
Type locality: Kaerimizu, Akago-mura, Mine-gun, Yamaguchi Prefecture, Southwestern Honshu, Japan.
Geologic horizon: *Pseudofusulina* zone.

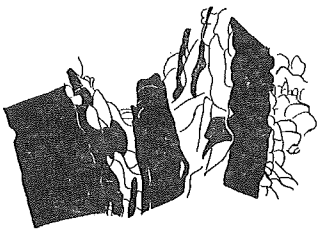
Remarks: The present species was first assigned by OZAWA with a slight doubt into *Waagenophyllum*. Then DOBROLYUBOVA placed it in *Stylidophyllum* and the senior author once followed her in this regard. In a recent restudy of the original material, however, the senior author came to believe that the former view should be revised. Because fairly well developed clinotabulae and elongate dissepiments are seen in the present species. Accordingly, the species, now in question, must be transfered from *Stylidophyllum* and would be better placed into *Wentzelella*. Yet, the present species markedly differs from the common species belonging to

Wentzelella in having thick septal walls and septa of two orders, and we finally decided to propose a new genus with this coral as the type species.

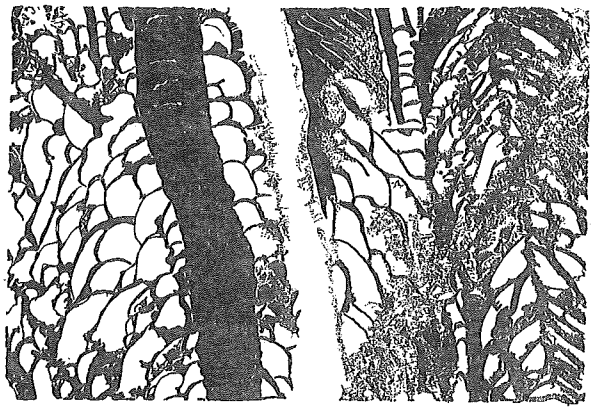
DOBROLYUBOVA described and figured a coral from Ural under the name of *Lonsdaleia* (*Stylidophyllum*) cf. *yokoyamai* and the senior author once carelessly listed this coral in the synonym list of the present species. However, DOBROLYUBOVA's species has walls which are not very much thickened by septal ends as in the present species. In addition, it seems to lack clinotabulae. Further, transverse tabulae mostly incline from inwards towards outwards. Therefore the Ural species does not seem to have any intimate relation to the present species.

Now, the present species is a good horizon indicator for the *Pseudofusulina* zone in the Akiyoshi limestone district of S.W. Japan, although OZAWA described its horizon to range from Ouralian to the Lower Permian, and the author once described it to be the *Parafusulina* zone.

The *Parafusulina* zone in the former description was, in fact, termed to denote a wider sense, than the present usage. The meaning of which was thought to



Text-figure 49
Yokoyamaella (*Yokoyamaella*) *yokoyamai* (OZAWA) (× ca.4); Kaerimizu, Akiyoshi-dai, Yamaguchi Prefecture. *Pseudofusulina* zone. UHR 18148 b.



Text-figure 50
Yokoyamaella (*Yokoyamaella*) *yokoyamai* (OZAWA) (×10); Kaerimizu, Akiyoshi-dai, Yamaguchi Prefecture. *Pseudofusulina* zone. III 63, OZAWA collection, Tokyo Univ.

include the *Pseudofusulina* to the *Parafusulina* zone of the present paper. According to HASEGAWA, who studied the stratigraphical sequence there in detail, however, the present coral is found in association with *Pseudofusulina kraffti magna* TORIYAMA, *Pseudofusulina* sp., *Schubertella* cf. *kingi* DUNBAR et SKINNER etc. Further, the present coral is found everywhere in the bed lying immediately on the *Pseudoschwagerina* limestone in field and at the same time is covered by the *Parafusulina* limestone.

HERITSCH once listed the present species from the Roterosa limestone of Trogkofel stage, however no information on this specimen is available, yet. However, the stratigraphical horizon of this coral seems to be almost equivalent to that of the present species in Japan.

Recently YAMAGIWA established '*Stylidophyllum*' *matsunagiense* and *Wentzelella shimoyukawensis* from the Atetsu limestone plateau (1962). But in our opinion, both of these forms are specifically not distinguishable from *Yokoyamaella yokoyamai* here described. Thus the species is now known to occur in the Atetsu region. Stratigraphic position of Atetsu specimens seem to correspond to that in the Akiyoshi region.

Yokoyamaella* (*Yokoyamaella*) *stillei (HERITSCH)

1936 *Wentzelella stillei* HERITSCH, p. 127, pl. 18, figs. 1, 2; text-figs. (text-fig. pl. 3) 29, 30, 31.

Holotype: No. 2468, Geol. Inst. Univ. Graz. Slide numbers: 2468, a, b, c, d.

Type locality: Lower *Schwagerina* limestone at a roadside near the church of Upper Rattendorf Alps.

Geological horizon: Lower *Pseudoschwagerina* zone.

Remarks: This species differs from the type species of the genus *Yokoyamaella* in showing more or less variable nature in walls, which are generally thickly decorated by mural septa, but the thickened zone does not seem to be as regular as in the type species. In addition, lonsdaleoid dissepiments seem to be sometimes composed of larger vesicles than the type species, although both species lack such dissepiments in the earlier stage of ontogeny.

The axial structure does not seem to show a marked difference between the present species and the type species of *Yokoyamaella*, especially in their early ontogenetic stage. It is generally simply constructed by less numerous lamellae and tabellae, though all of them are very much thickened by organic deposits. However, the axial structure of the present species becomes finely constructed in the mature stage. Especially, the tabellae occasionally become vesiculate and numuerous, giving a quite different aspect from that of the type species. In the type species, the axial column is usually quite simply constructed even in the mature

stage by a thick median plate and less numerous thick tabellae and lamellae.

Further, in both the present and the preceding species, no remarkable boundary line distinguishing the neighbouring corallites can be observed at the walls, which are considerably strengthend by thick septal ends. However, the septa of the preceding species seem to have a white or translucent layer in the middle portion at the cross section, while the present species possesses septa showing a dark line at the middle part.

Yokoyamaella (*Yokoyamaella*) *tertioseptata* (YOKOYAMA)

Pl. 11, figs. 1–2.

1960 *Stylidophyllum yokoyamai tertioseptatum* YOKOYAMA, p. 245, pl. 27, figs. 1a–c.
1962 *Stylidophyllum yokoyamai tertioseptatum*, YAMAGIWA, p. 91, pl. 4, figs. 4–6.
Holotype: IGSH Y. T. no. 6.
Type locality: Gray coloured limestone cropped out at about 200 m north from the Misaka primary school, Misaka, Taishaku district, Hiroshima Prefecture, S.W. Honshu, Japan.
Geological horizon: *Pseudoschwagerina* to *Pseudofusulina* zone.

According to YOKOYAMA, who first described the present coral, it came from limestone representing the *Pseudoschwagerina* zone in association with fusulinid formainifera and other corals. But, NOGAMI stated (1962) that a coral conspecific with the present species was also found in the limestone of the *Pseudofusulina* age at other localities in Atetsu, not far from the type locality.

Remarks: The present form is closely akin to the type species of the genus *Yokoyamaella*. Based on a careful observation of the original material, however, the present form was found to have septa, with the middle line showing as a dark layer in most cases, while rarely having translucent layers. Whereas, the type species always has a white layer in the middle of the septa.

Further, in the type species, a distinct boundary line is not recognizable between the neighbouring corallites. Namely, the walls are composed of thickened mural septa in which no distinct boundary clearly distinguishing the two corallites can be observed in the type species. On the contrary, in the present species, dark lines or closely situated black dotted lines are observable with certainty at the boundary between the neighbouring corallites. In this regard, the present form is closer to *Yokoyamaella kurohime* nov., which will be later described in detail.

In addition, the present form seems to be more vesiculate in the peripheral zone by lonsdaleoid dissepiments, than the type species. Also, the axial structure is more finely and narrowly constructed. (However, those two points may be only a matter of degree and cannot be regarded to be conclusive criteria to specifically distinguish the two forms).

Finally, YOKOYAMA stated that tertiary septa are seen occasionally and are locally developed in the present form. If it is true, it may be an important obseration.

However, the so-called tertiary septa designated by YOKOYAMA are, actually, only found in rather smaller and immature corallites. The so-called tertiary septa may accordingly not be the tertiary septa but rather immature (secondary) septa. It is quite certain through our observation, that the relatively shorter septa alternating with the so-called tertiary septa are, in reality, major septa which have not attained maturity. They are only found in the immature stage of coralites in smaller size.

Thus, we cannot conceive the possibility of a development of tertiary septa in the present form. Hence the present form may be safely assignable into the genus *Yokoyamaella*.

Further, it may be quite reasonable to regard that the present form is specifically distinct from the type species through the facts above described and hence to raise the present form to an independent species, instead of a mere variety of the latter.

Yokoyamaella* (*Yokoyamaella*) *carinthiaca (HERITSCH)

1936 *Styldiophyllum floriformis* MARTIN var. *carinthiaca*, HERITSCH, p. 125, pl. 18, figs. 3, 4; text-fig. 19 (text-fig. pl. 3).
Type specimen: Corallum given by HERITSCH in his plate 18, (slide 484) is here designated as the lectotype of the present species.
Type locality: The Rattendorf meadow and from beneath the church at the Rattendorf Alps, Carnic Alps.
Geological horizon: Lower *Pseudoschwagerina* zone.

Remarks: The present species provides thick walls made of mural septa and solid to rather simple axial structure strongly thickened by organic deposits. Further, it has septa of only two orders.

The present species doubtlessly resembles *Yokoyamaella stillei* described by HERITSCH also from the Carnic Alps in many points, but it may be specifically distinct from the latter in having far smaller corallites even though the corallum reaches a full grown stage and more well developed lonsdaleoid dissepiments.

The longitudinal sections for the present species were unfortunately not illustrated by HERITSCH and the description regadring these sections were also not given. Yet there is hardly any possibility that the present form belongs to the genus *Stylidophyllum*.

Yokoyamaella (*Yokoyamaella?*) *kaludjeracensis* sp. nov.

1954 *Stylidophyllum denticulatum*, KOSTIC-PODGORSKA, p. 115 (non HUANG, 1932), pls. 1–3.
Type: The specimen illustrated by KOSTIC-PODGORSKA in plate 3 is here designated as the type of the present species.
Type locality: Kaludjerac (Petrovac a/m), "Montenegrisch" coastal region, Jugoslavia.
Geological horizon: *Pseudofusulina* zone. According to KOCHANSKY-DEVIDE (in KAHLER p. 76, 1960), *Pseudofusulina solida* was found in the limestone, which may be stratigraphically almost equivalent to the limestone bearing the present coral. KAHLER is now of opinion that the coral horizon of the present species may be correlatable to the red limestone of the Trogkofel formation of the Carnic Alps in rough estimation.

Diagnosis: With a different type of wall which is deviated from that of the type species of *Yokoyamaella* but rather resembles that of the genus *Wentzelophyllum*. Yet, other skeletal forms are identical with that of *Yokoyamaella*, including septa in only two orders.
Remarks: The present species seems to be quite different from " *Stylidophyllum* " *denticulatum* described by HUANG, because the former has quite different types of walls from the latter. Further, in the former, crestal septa seem to be scarce, if any, while they are definitely numerous in the latter. Accordingly, there is no doubt that the present form is specifically quite distinct from HUANG's species.

The illustrations of the present form given by KOSTIC-PODGORSKA were unfortunately too rough to give any idea of the detailed structure of the corallites, yet the columella seems to be rather solid at least in the earlier stage of ontogeny. Such a nature is also recognizable in almost every other species belonging to *Yokoyamaella*.

In addition, the septa of the present form are only in two orders. Therefore, the present form may be well placed into Waagenophyllinae with certainty.

However, the wall of the present form is of a different type being considerably deviated from that of the type species of *Yokoyamaella* but apparently resembling that of *Wentzelophyllum*, which belongs to Wentzelophyllinae. Such being the case, we tentatively place the present species into the genus *Yokoyamaella* with some doubt.

Yokoyamaella (*Yokoyamaella*) *kurohime*, sp. nov.

pl. 10, fig. 1.

Holotype: U. H. Reg. nos. 18151a, b, c, d. (slides)
Derivation of specific name: The present coral was found by A. SAITO, at the top of

Mt. Kurohime, which became the specific name.
Type locality: The summit of Mt. Kurohime, Omi-cho, Nishi-kubiki-gun, Niigata Prefecture, Honshu, Japan.
Geological horizon: *Pseudofusulina* zone.

Specific diagnosis: With rather solid columella composed of very thick median plates, septal lamellae and very few tabellae. Septa are thick, with thick dark layers in the middle portion. Also, with dark layers in the middle part of mural septal zone. Lonsdaleoid dissepiments are locally developing in every corallite, even in the mature stage. Wall is originally thin but thickly decorated by mural septa.

Description: Corallum compound, massive; corallites are irregularly polygonal, with walls generally not straight but curved in the cross section. Walls are very thin but strengthened by thick mural septa, completely joining each other. In the zone of mural septa, the boundary between the neighbouring corallites is always indicated by the presence of thick dark lines or closely set dark dotted lines.

Septa are in two orders. Of these, the major ones are very long, nearly reaching the axial structure, but do not unite with it, except for counter septum. Major septa are also very thick in their medial zone, and locally completely uniting with their lateral margin. In most parts of the corallites, septa are observed to grow directly from the mural septa, and the former seem to be entirely continuous with the latter, while in other parts, septa frequently appear to be disconnected with the mural septa by the presence of dark lines between them, even though no lonsdaleoid dissepiments develop. Minor septa are far shorter than the major ones, but show nearly the same width of the latter. All these septa provide dark layers in the middle portion, and are dilated by thick stereoplasmic deposits. The axial ends of the septa are frequently rhopaloid.

The axial structure is almost solid, especially in the relatively early stage of ontogeny, when the cardinal septum unites with the axial column. In the mature stage, median plate, or septal lamellae like structure come to develop inside the solid columella. In addition, tabellae finally show a growth and the axial structure seems to be locally poorly vesiculate, although a thick circular layer is still retained, encircling the axial column.

Dissepiments are not numerous, besides lonsdaleoid dissepiments are only locally present in nearly every corallite, but they are mostly small in size, even in the full grown stage.

In the longitudinal section, the axial zone is well bounded from tabularium by a thickly constructed axial column, which is composed of nearly straight and thick, median plate, rather thin but steeply ascending conical tabellae, and very thick septal lamellae.

Transverse tabulae are narrow, thin and nearly horizontal, and very sporadical in distribution.

Clinotabulae are comparatively large, but do not steeply incline. Elongate

dissepiments are also large, showing nearly the same inclination as clinotabulae. Globose dissepiments are represented by smaller sized vesicles, which are locally hardly distinguishable from the lonsdaleoid vesicles.

All these tabulae and dissepiments are thickly dilated by deposits in general. Walls are thin, but strengthened thickly by characteristic mural septa, the growth direction of which tends to subhorizontal or a little upwards.

In the central part of the mural septal zone there is a dark layer, which may be the boundary between the neighbouring corallites.

The results of measurements are as follows:

Calicular diameter	septal number	axial column	Lonsd. dissepim.
3.0 mm	9– 9	solid	none
5.0 mm	13–13	solid	very sparse
6.0 mm	15–15	solid	very sparse
7.0 mm	16–16	septal lamellae appear	fairly numerous
7.0 mm	16–16	septal lamellae plus tabellae appear	fairly numerous

Remarks: The present form closely resembles the type species of *Yokoyamaella*. However, the septa in the present form provide a very thick dark layer in the middle portion, as against the translucent layer in the latter. Further, the boundary between the neighbouring corallites is always indicated in the present form by thick black lines, while such boundary lines cannot be recognized in the type species, or at least are quite ambiguous, if any. So the distinction between these two forms may be not difficult.

Next, the present form seems also to somewhat resemble *Yokoyamaella tertioseptata* (YOKOYAMA), but the nature of axial structure seems to be fairly different between the two, especially in the mature stage. The present form possesses axial structure being more solid and less vesiculate even in the mature stage than that of *tertioseptata*. Also, the degree of development between these two forms regarding lonsdaleoid dissepiments is considerably different. In the present form, such dissepiments are always observed only in local parts of the corallites, especially near the wall.

Subgenus ***Maoriphyllum*** nov.

Type species: *Wentzelella maoria* LEED, 1956.

Diagnosis: Almost the same with the genus *Yokoyamaella* in the fundamental structures of corallites, but septa show a somewhat thamnasterioid trend. Further, septal walls are always composed of long septa, instead of short mural septa.

Geological range: Uppermost *Neoschwagerina* to *Yabeina* zone.
Geographical distribution: New Zealand and Japan.

Included species:

Yokoyamaella (*Maoriphyllum*) *maoria* (LEED)
Yokoyamaella (*Maoriphyllum*) *minense* nov.
Yokoyamaella (*Maoriphyllum*) *ozawai* (MINATO)
Yokoyamaella (*Maoriphyllum*) *matsushitae* (YAMAGIWA)
Yokoyamaella (*Maoriphyllum*) *nishinense* (YAMAGIWA)

Remarks: The newly proposed subgenus can be distinguished from *Yokoyamaella* chiefly in the following points. First of all, septa in this group show a somewhat thamnasterioid trend, as described in the subgeneric diagnosis. Next, septa in *Yokoyamaella* are observed to be not always continuous from the mural septa forming walls, but in reality there are frequently interruptions or discontinuities between septa and mural septa. That is to say, septa are not always direct prolongations of the mural septa. On the contrary, there are no distinct mural septa which are discontinuous from the septa in this group.

Actually, mural septa are not well differntiated from septa in the present sub-genus, but the septa themselves form walls with their thick septal ends. Namely the septa are laterally jointed with each other to form septal walls, at the same time, the neighbouring corallites completely unite with each other with such septal walls. In other words, septa of the neighbouring corallites directly unite at walls. As a result, there is no remarkable boundary between corallites as in the case of the genus *Yokoyamaella* s. str. Nevertheless, septal ends of septal walls cannot be regarded as mural septa, which are not entirely independent from septa in the present sub-genus.

Thirdly, the columella is more solid, even in the mature stage, than that of *Yokoyamaella*.

Further, this group of corals show a younger geological range compared to *Yokoyamaella*. Thus, this group of corals would be better distinguished from *Yokoyamaella* in subgeneric rank, although they are quite close to each other, because they have walls thickened by septa.

The next problem is how to consider the relation between the newly proposed subgenus and *Lonsdaleiastraea*. In this regard, we have had long discussions and have finally concluded that the difference between them is decidedly larger than the distinction found between *Maoriphyllum* and *Yokoyamaella* s. str. Because, the present sub-genus lacks entirely in tertiary septa as in the case of *Yokoyamaella*, while tertirary septa are always found in *Lonsdaleiastraea*.

Of the five species being placed in the sub-genus *Maoriphyllum*, New Zealand species and *minense* are rather similar, while *ozawai* seems to be considerably deviated from other two and it shows a rather intermediate nature between *Yoko-*

yamaella and *Lonsdaleiastraea*. In other words, *ozawai* seems to be not completely congeneric with *Yokoyamaella*, *Maoriphyllum*, or with *Lonsdaleiastraea*.

Namely, the nature of septa of *ozawai* more closely resembles that of *Yokoyamaella*, besides having thick septal walls, which are partly composed of mural septa but are still retained in some parts of the corallites. In addition, the walls are partly suppressed and septa locally have a thamansterioid appearance, the feature of which is quite unlike *Yokoyamaella*.

Nevertheless, this species has no tertiary or higher orders of septa. It is accordingly not unreasonable to place this species under the subgenus *Maoriphyllum*.

Yokoyamaella* (*Maoriphyllum*) *maoria (LEED)

1956 *Wentzelella maoria* LEED, p. 19, pl. 5, text-fig. 2.
Holotype: New Zealand Geol. Surv. Corallum Co. 1264, slides C 1013, 1014, 1016, 1017. British Museum (Natural Hist.) slides R. 39602, 39603.
Type locality: G. S. 5074, Marble bay, east of Tauranga bay, Whangaroa, Grid reference N 8/301838.
Geological horizon: *Yabeina* zone, after personal communication given by Prof. D. HILL to the senior author (see HORNIBROOK).

Remarks: This species possesses columella almost solid and fairly large. So far as the figures illustrated by LEED on plate 5 are concerned, thin wall like boundary lines are still retained between the neighbouring corallites.

We doubt, however, that such boundary lines originally existed. In careful observation of fig. 1 of plate 5, shows septa of the neighbouring corallites seemingly united and perfectly confluent in most cases. As a result, there is no remarkable boundary line retained between corallites, at least in most corallites observable.

Nevertheless, well dilated septa without exception laterally unite with each other, and form septal walls.

The feature may be regarded as a criterion to place the present species into *Yokoyamaella* (s. l.) instead of *Lonsdaleiastraea*, even though the order of septa are temporarily ignored.

Yokoyamaella* (*Maoriphyllum*) *minense, nov.

1955 *Lonsdaleisatraea nipponica*, MINATO (par.), p. 134, p.l 34, fig. 6; pl. 43, fig. 2 (non pl. 30, fig. 5).
Holotype: The specimen given by MINATO in his plate 34 and 43 is here designated as the holotype. OZAWA Coll. III 62.
Type locality: Shiraiwa (loc. III 62 of the late Dr. Y. OZAWA), Ominemura, Mine-gun,

Yamaguchi Prefecture, Japan. The specimen is now stored at the Inst. Geol. Tokyo Univ.
Geological horizon: *Yabeina* zone.

Remarks: The type specimen termed by the author as *Lonsdaleiastraea nipponica* has recently been found to be specifically distinct from the OZAWA's specimen, although the latter was once presented by the senior author under the same name as the former.

These two are different in the minor structure of septa, instead of giving a superficially similar appearance in general form of corallites.

The present form possesses rather smaller sized columella, which has a solid to simply constructed axial structure with lamellae and tabellae, strongly thickened by organic deposits. Septa are variable in thickness, but are normally very much dilated and have a thamnasterioid tendency. Walls are septal walls, composed of dilated septa and no remarkable boundary lines in the zone of wall are seen. In the longitudinal section, a characteristic septal wall is seen as in the case of *Yokoyamaella*.

The present form somewhat resembles the preceding species, but columella is smaller and septa are partly thin, although they are mostly as thick as the preceding species.

Yokoyamaella* (*Maoriphyllum*) *ozawai (MINATO)

Pl. 12, figs. 1–2.

1925 *Lonsdaleia* (*Waagenophyllum*) *frechi*, OZAWA (non VOLZ), p. 72, pl. 12, fig. 8.
1955 *Wentzelella ozawai* MINATO, p. 110, pl. 25, figs. 5, 7; pl. 30, fig. 8; text-figs. 8B, 1–3.

Type specimen: The slide figured by MINATO in his plate 30 is here designated as the lectotype of the present species. OZAWA Coll. III 54.
Type locality: Shibukura, Omine-mura, Akiyoshidai, Yamaguchi Prefecture.
Geological horizon: According to HASEGAWA of our department, the specimen came from limestone containing *Gifuella douvillei* (OZAWA), hence the age is the uppermost *Neoschwagerina* zone.

Remarks: As it was stated in the foregoing pages, this species possesses walls, referable to the genus *Yokoyamaella* on one side, while the septa tend to thamnasterioid.

In any event, owing to the imperfection of the specimen the characters of this species cannot be stated with certainty, although it is beyond doubt that this species is not identical with *Lonsdaleia frechi* VOLZ, which is in reality a species of *Polythecalis*.

In this form, walls are formed by thick septal ends, so far as they are still

retained in some parts of corallites. Besides, tertiary septa are absent and there are almost no lonsdaleoid dissepiments at the periphery.

Further, the so-called thamnasterioid trend is not prominent in this species as in the case of the typical *Lonsdaleiastraea*. Thus the present form reminds us of *Wentzelloides* to some extent, putting the non-existence of tertiary septa aside for a while.

In any event, this is a transitional or intermediate form between *Yokoyamaella* and *Lonsdaleiastraea* and must tentatively be placed under the subgenus *Maoriphyllum*.

Yokoyamaella* (*Maoriphyllum*) *matsushitae (YAMAGIWA)

1962: *Lonsdaleiastraea matsushitae* YAMAGIWA, p. 93, pl. 8, figs. 1, 2.
Holotype: Nos. 60055–6. Osaka Univ. of Liberal Arts & Education.
Type locality: Loc. no. 27, north of Matsunagi, Atetsu plateau, Okayama Prefecture.
Geological horizon: *Neoschwagerina* zone.

Remarks: According to the description of the present species given by YAMAGIWA, it does not have three or more orders of septa. Therefore the assignment of the present species to *Lonsdaleiastraea* is not followed here. On the contrary *Yokoyamaella* (*Maoriphyllum*) seems to well accomodate the present form. The species now in concern may be comparable with *Yokoyamaella* (*Maoriphyllum*) *minense* from Akiyoshi region. But the former is distinguished from the latter in posessing decidedly large corallites.

Yokoyamaella* (*Maoriphyllum*) *nishinense (YAMAGIWA)

1962 *Lonsdaleiastraea nishinense* YAMAGIWA, p. 93, pl. 8, figs. 4, 5.
Holotype: Nos. 60058–9, Osaka Univ. of Liberal Arts & Education.
Type locality: Loc. 28, about 1 km East of Maki, Atetsu plateau, Okayama Prefecture.
Geological horizon: *Yabeina* zone.

Remarks: For the reasons given above the present species also is considered here as a form of *Yokoyamaella* (*Maoriphyllum*). The species is comparable to *Yokoyamaella* (*Maoriphyllum*) *ozawai* (MINATO), but is distinguished from the latter in having small axial column and corallites.

Genus ***Ipciphyllum*** HUDSON, 1958

Type species: *Ipciphyllum ipci* HUDSON, 1958. = *Ipciphyllum laosense* (PATTE)

1958 *Ipciphyllum* HUDSON, p. 179.
1962 *Ipciphyllum* WU, p. 494, 501.

Diagnosis: Cerioid Waagenophyllinae with thin wall in general. Dissepiments mainly interseptal, but occasionally non septate. Elongate dissepiments present but not well developed. Clinotabulae also develop in various degrees.

Geographical distribution: Turkey, Iraq, Iran, Indo-China, South China, Timor, and Japan.
Geological range: *Parafusulina-Yabeina* zone.

Remarks: *Ipciphyllum* seems to be structurally simpler than *Wentzelella* in lacking tertiary septa. Nevertheless, the former shows its geological range to be relatively later than that of the latter. This may indicate that these two genera are different in origin, though they apparently resemble each other. Possibly, *Wentzelella* may have evolved from certain corals apparently resembling *Lithostrotion* in obtaining complexity in its axial structure and adding elongate dissepiments besides clinotabulae as new skeletal elements, while *Ipciphyllum* may have branched from some coral apparently resembling *Stylidophyllum* in gradually losing lonsdaleoid dissepiments but gaining clinotabulae, and elongate dissepiments.

Therefore the earliest forms of the genus *Ipciphyllum* is sometimes hardly distinguishable from *Stylidophyllum*, except for minor differences in the morphology regarding dissepiments and tabulae.

Also the genus *Ipciphyllum* shows a close resemblance to *Parawentzelella* but differs from it in lacking so-called canals, besides the wall of the former is generally thinner than that of the latter. While *Ipciphyllum* seems also to resemble *Wentzelophyllum* to some extent but is different in the thickness and type of wall (See terminology concerning to walls) and in the degree of development of lonsdaleoid dissepiments.

Key to species of the genus *Ipciphyllum*

I With broad transverse tabulae
- a) With well developed lonsdaleoid dissepiments
  - With indistinct median plate in axial column ..... *laosense*
  - With small axial column provided with distinct median plate.... *heritschi*
  - With irregularly developed lonsdaleoid dissepiments and short minor septa ..... *irregularis*
- b) Without well developed lonsdaleoid dissepiments
  - With very thick septa near the wall ..... *timoricum*
  - With less thick septa near the wall ..... *subtimoricum*
  - With well developed clinotabulae ..... *kwangsiense*
  - With thin septa and small axial column..... *persicum*
  - With short minor septa..... *elegans*

With distinct median plate in axial column and relatively longer minor septa ..... *subelegans*

II With narrow transverse tabulae

a) With well developed lonsdaleoid dissepiments

Without septal lamellae in axial column..... *gnomeiense*

b) Without well developed lonsdaleoid dissepiments

With relatively small corallites..... *huangi*

With large corallites and long minor septa ..... *flexuosum*

With short minor septa ..... *anatolicum*

With simple columella and well developed clinotabulae..... *simplex*

Ipciphyllum laosense (PATTE)

Pl. 1, fig. 8; Pl. 16, figs. 6–8;
Text-figs. 5a, 5d, 51–52.

1908 *Lonsdaleia indica*, MANSUY, p. 55, pl. 14, figs. 2, 2a.
(non *Lonsdaleia indica* WAAGEN and WENTZEL 1886).
1912 *Lonsdaleia indica*, MANSUY, p. 9, pl. 1, figs. 3a–c; pl. 2, fig. 1.
1925 *Lonsdaleia* (*Waagenophyllum*) *timorica*, OZAWA, p. 74, pl. 13, figs. 7–9.
(non *Lonsdaleia timorica* GERTH, 1921).
1926 *Lonsdaleia indica* var. *laosensis*, PATTE, p. 59–60, pl. 7, fig. 19.
1936 *Wentzelella subtimorica*, DOUGLAS, p. 23, pl. 2, fig. 2; pl. 3, f.g. 5.
(non *Wentzelella subtimorica* HUANG 1932)
1939 *Wentzelella subtimorica*, HERITSCH, p. 173, pl. 1, figs. 2, 3; pl. 2, figs. 7, 8, 15–17.
1944 *Wentzelella subtimorica*, MINATO, p. 105, figs. 1–3.
1955 *Wentzelella subtimorica*, FLÜGEL, p. 301, p. 34, figs. 7–8.
1955 *Wentzelella subtimorica*, MINATO, p. 113, pl. 22, fig. 8; pl. 23, fig. 7; pl. 25, fig. 2; pl. 26, fig. 3; pl. 30, fig. 1; text-fig. 8c, 1, 2, 3, 4.
1958 *Ipciphyllum ipci*, HUDSON, p. 179, pl. 33, figs. 1–3, 7, 10; pl. 35, fig. 4.
1961 *Wentzelella laosensis*, FONTAINE, p. 174, pl. 21, figs. 1–5, 8–9.

Lectotype: Slides given by FONTAINE in figures 2, 3, 4 and 5 on plate 21. Now stored at Musée Paleontologique de l'Ecole des Mines de Paris.

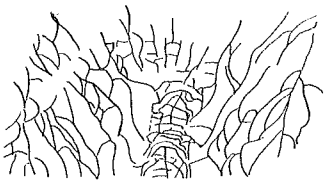
Type locality: Pong Oua, Laos.

Geological range: *Parafusulina*, *Neoschwagerina*—*Yabeina* zone.

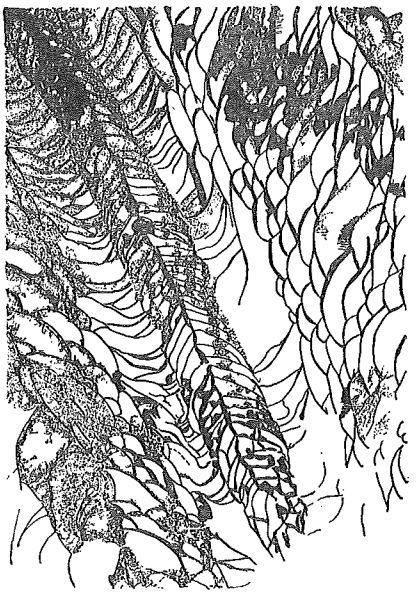
Remarks: The present form is rather variable in size of corallites, septal number, thickness of wall, construction of axial column, etc., but alway posesses lonsdaleoid dissepiments developing in various degrees and rather wide transverse tabulae which are mostly sub-horizontal.

Except for the development of lonsdaleoid dissepiments, the present form is closely akin to " *Wentzelella* " *subtimorica* HUANG, which was also placed by HUDSON into his newly established genus *Ipciphyllum*.

The Japanese specimens belong to the former species, in that they are provided with fairly well developed lonsdaleoid dissepiments, besides having remarkably wide sub-horizontal transverse tabulae.



Text-figure 51
Ipciphyllum laosense (PATTE) (×6.2) Shigeyasu, Miné city, Yamaguchi Prefecture. *Yabeina*? zone or *Parafusulina*? zone. UHR 18175.



Text-figure 52
Ipciphyllum laosense (PATTE) (×10) Shigeyasu, Miné city, Yamaguchi Prefecture. *Yabeina*? zone or *Parafusulina*? zone. UHR 18173.

The specimen formerly given by the senior author in 1955 is the same material once described by OZAWA as *Lonsdaleia* (*Waagenophyllum*) *timorica* OZAWA. All of them, however, do not belong to either GERTH's *timorica*, or HUANG's species *subtimorica*. HUDSON, who established *Ipciphyllum ipci* in 1958, placed the OZAWA material in his synonym list as conspecific, but eliminated MINATO's specimen.

Geographical distribution: Turkey, Iraq, Iran, Laos, Viet-Nam and Japan.
Specimens in our repository: Reg. nos. 18175–18177, Serita, Akiyoshi limestone plateau, Yamaguchi prefecture; Reg. no. 18172, Shiraiwa, Akiyoshi limestone plateau (*Yabeina* zone); Reg. nos. 18173–18174, Shigeyasu, Akiyoshi limestone plateau..

Ipciphyllum heritschi, sp. nov.

1939 *Stylidophyllum gnomeiense*, HERITSH, p. 6, pl. 1, figs. 4, 5; pl. 2, figs. 11, 12. (non *Stylidophyllum gnomeiense* HUANG, 1932).
Type: The specimen given by HERITSH as figs. 4, 5 on plate 1 is here designated as the lectotype.
Type locality: Permian of Ala Dagh, Kilikisher Taurus, Turkey.

Diagnosis: *Ipciphyllum* with well developed lonsdaleoid dissepiments, a thin wall, and smaller axial column in which the median plate is distinct.
Remarks: Although HERITSCH did not illustrate the longitudinal section of this species, it can be considered to have a rather wide tabularium with sub-horizontal transverse tabulae. The present form somewhat resembles *Stylidophyllum gnomeiense* described by HUANG' as was believed by HERITSCH, but actually it is specifically different through the reasons given in the remarks of the HUANG's species.

The present form was also referred to " *Lonsdaleia* " *chaoi* var. described by HUDSON in 1958 from Iraq, but it must be also specifically distinguished from the latter, because of its slightly smaller corallites and less numerous septa than the Iraq form; further, in the present form, lonsdaleoid dissepiments are well developed, yet this structure is more highly developed in HUDSON's coral; in the Iraq form, there is no peripheral area with septa in any of the corallites illustrated; on the contrary, in the present form for which a new name is here given, there are still some septated areas at the periphery in almost all corallites.

Also, the axial column may be worthy of note in the present form, in which the median plate is in general prominent against a rather less distinct development of the said plate in the Iraq specimen.

All of these points given above may be of little importance in the specific classification, but if they were combined en masse, they can be justifiably considered to separate specifically the present form from HUDSON's species.

The present form is also closely akin to the preceding species, but is specifically distinct in having a prominent median plate in the axial column, which is rather small in size.

Ipciphyllum irregularis (FONTAINE)

1961 *Wentzelella irregularis* FONTAINE, p. 177, pl. 22, figs. 4–7; pl. 23, fig. 1.
Syntype: FONTAINE collection no. 714, 697, 695.
Type locality; Ba-Hon, Ta-Tien district, South Viet-Nam.
Geological age: *Neoschwagerina* zone.

Diagnosis: *Ipciphyllum* with irregularly developing lonsdaleoid dissepiments and short minor septa.
Remarks: This coral is quite variable in its nature of axial column and in its degree of development of lonsdaleoid dissepiments. As it is clearly observable from the figures, illustrated by FONTAINE, the lonsdaleoid dissepiments show an extremely various nature from corallite to corallite, even in the full grown stage.

Nevertheless, there is not a single corallite without lonsdaleoid dissepiments. Also the axial column gives a considerably different aspect in the corallites, some are simply constructued but others are more complex.

In its thin wall and shorter minor septa, this species resembles "*Lonsdaleia*" *chaoi* var. of HUDSON, but the latter has an arachnoid column, besides the latter shows quite a different aspect in the longitudinal section from the former.

The present form may be a quite important species linking typical *Ipciphyllum* like *I. laosensis* and *I. elegans*. The latter possesses rather broad transverse tabulae, but is lacking in lonsdaleoid dissepiments. Possibly the latter may have evolved from the former through an intermediate form such as the present form.

Ipciphyllum timoricum (GERTH)

1921 *Lonsdaleia timorica* GERTH, p. 74, pl. 145, figs. 1, 2.
(non *Wentzelella timorica*, HUANG, 1932).
Lectotype: A specimen given by GERTH will be chosen as the type.
Type locality: Not defined, and localitits are: Kaslioe B, S.; Fatoe Oinino at a road side for Nenas in Moetis Mountain; Noil Boewan at a road side Niki-Niki (Nr. 661, B.S.) and Oi Ekan (No. 447, ser. 4D. S.), Timor.
Geological horizon: Unknown.

Diagnosis: With thin wall, without lonsdaleoid dissepiments but with septa especially thick near the walls.
Remarks: The present form is quite distinct from all other hitherto known species belonging to *Ipciphyllum* in having highly thickened septa at wall; the latter of which is originally very thin.

In having a wide and complex axial column and in possessing no lonsdaleoid dissepiments, the present form is closely akin to *Ipciphyllum huangi* nov., but the former has decidedly thick septa at walls.

The walls of the present form somewhat resemble septal walls, because the septa become very thick near the wall, representing a spatulate form, and laterally completely uniting with each other; the septa at walls are accordingly have the appearance of mural septa. Therefore, the present form seems to be reasonably assignable into the genus *Yokoyamaella*.

However, in the present form, the existence of thin walls is almost always

seen between neighbouring corallites, so far as the illustrated corallum is concerned. In addition, septa of the neighbouring corallites cannot be regarded to be so completely confluent that the boundary lines between the corallites have become obsolete. Further, the axial column of the present form is not as solid as *Yokoyamaella*.

Thus, the present form could be placed into *Ipciphyllum*, instead of having thick septa at walls.

Ipciphyllum subtimoricum (HUANG)

1932 *Wentzelella subtimorica* HUANG, p. 59, pl. 4, figs. 1a, 1b.
1958 *Ipciphyllum* cfr. *subtimorica*, HUDSON, p. 181, pl. 33, figs. 5, 8.
Holotype: Cat. no. 3863, Geol. Surv. China.
Type locality: Permian limestone 1 li east of Laochialiang, Lipohsien, South Kueichow, Loc. no. T2 68.
Geological horizon: *Neoschwagerina* zone.

Remarks: The present species is distinguishable from the preceding species in having far thinner septa at walls.

It must be noted that these two forms possess rather wide transverse tabulae, while clinotabulae are less developing, though not completely lacking. On the contrary, elongate dissepiments develop in various degrees.

Up to the present, many authors including the authors have regarded the limit of the present species to be more wider and have placed many forms (referable to *Ipciphyllum laosense* in the present paper) into the species now in concern.

However, *Ipciphyllum laosense* has lonsdaleoid dissepiments, developing in various degrees, while the present species is lacking in a non septate dissepimental zone or, at least, is quite free from lonsdaleoid dissepiments. Otherwise there is no remarkable difference between them.

Ipciphyllum subtimoricum kwangsiense WU

1963 *Ipciphyllum subtimoricum* var. *kwangsiense* WU, p. 583, pl. 2, figs. 1–2.
Horizon and locality: Heshan suite, Upper Permian, Yishan district, Kwangsi.
Holotype: Cat. nos. 14037 and 14038.

Remarks: We believe that the present form is merely distinguishable from the species called *subtimoricum* in having corallites of irregular size and rather well developed clinotabulae. To distinguish this form from the typical species in the subspecific rank may be accordingly unreasonable. However we wish tentatively to follow WU's decision.

Ipciphyllum persicum (DOUGLAS)

1936 *Wentzelella persica* DOUGLAS, p. 24, pl. 2, fig. 3.
1956 *Wentzelella persica*, FLÜGEL, p. 304, pl. 34, fig. 9.
Holotype: Slide no. S.P.R. 896, specimen, G.S.I. Sp. no. 15905.
Type locality: Kuh Gaikan, Iraq.
Geological horizon: Possibly *Parafusulina* to *Neoschwagerina* zone.

Diagnosis: *Ipciphyllum* with weakly developed lonsdaleoid dissepiments, relatively smaller axial column and thinner septa.
Remarks: This species somewhat resembles *Ipciphyllum elegans* (HUANG), but is specifically distinct from the latter in having longer minor septa. In addition, the present form has lonsdaleoid dissepiments, although they are only composed of smaller sized vesicles.

The present species is more nearly akin to *Wentzelella laosensis* PATTE var. *tenuis* described by FONTAINE 1961 from Laos, but in the latter the walls are evidently thicker and corallites seem to be generally smaller than the former.

FLÜGEL described the present species from the Permian of Sub-Anatol Taurus. The described specimens have longer minor septa and weak developed lonsdaleoid dissepiments. Hence, they are referable to the DOUGLAS's species.

Ipciphyllum elegans (HUANG)

1932 *Wentzelella elegans* HUANG, p. 61, pl. 4, figs. 3, 4.
Non *Wentzelella elegans*, DOUGLAS, 1950, p. 13.
Non *Ipciphyllum elegans*, HUDSON 1958, p. 181.
Holotype: Cat. no. 3863, Geol. Surv. China.
Type locality: Chihsia limestone of Tsushihkuan, Tu'ngtzuhsien, Kueichow.
Geological horizon: *Parafusulina* zone (HUANG) 1932.

Diagnosis: *Ipciphyllum* with short minor septa but nearly lacking in lonsdaleoid dissepiments.
Remarks: The present species is characteristic in having shorter minor septa which are usually only 1/3 the length of the major septa. The specimens described and figured by HUDSON 1958 under the name *Ipciphyllum elegans* seem to be slightly different from the holotype, because in the latter, the median plate is quite distinct from the other septal lamellae in the axial column in the cross section. Further, the minor septa of the latter are in general longer than that of the holotype; they are nearly 4/6 to 3/4 the length of the major ones; while in the holotype, minor septa are almost less than 1/3 the length of the major septa. Except

for these two points, however, the Iraq specimens resemble the Chinese species quite closely.

HUANG gave another specimen collected from other localities beyond the type locality, which seems to be entirely conspecific with the holotype, as he believed.

Ipciphyllum subelegans, sp. nov.

? 1950 *Wentzelella elegans*, DOUGLAS, p. 13, pl. 2, fig. 7 (non *Wentzelella elegans* HUANG, 1932).
1958 *Wentzelella elegans*, HUDSON, p. 181, pl. 33, fig. 6, text-fig. 1.
Holotype: R. 42001 (two pieces) and sections a, b. (text-fig. 1) and c (pl. 33, fig. 6) of HUDSON, 1958. British Museum (Nat. Hist)
Type locality: *Wentzelella* limestone, Gelikhana section, Ora, Northern Iraq.
Geological age: *Neoschwagerina* zone.

Specific diagnosis: *Ipciphyllum* in which lonsdaleoid dissepiments are nearly entirely lacking. Median plate is quited istinct from septal lamellae and minor septa are long.
Remarks: The present form resembles *Ipciphyllum elegans* HUANG in many points, especially in possessing a thin wall and a rather wide space occupied by transverse tabulae and arachnoid axial column. As already described in the preceding species, the present form has decidedly longer minor septa than that of the HUANG's species. Further, in the present form, the median plate is quite prominent and distinct from other septal lamellae, clearly bisecting the axial column into two parts. These two points are sufficiently adequate to sepcifically separate the present from from *Ipciphyllum elegans* (HUANG).

In 1950 DOUGLAS described one coral also under the name of *Wentzelella elegans*, which was unfortunately not well figured, but according to the description given by him, the minor septa of that specimen may appear to be also much longer than the typical form of HUANG's species and they may be accordingly allied to the Iraq sepcimens now in question, although synonymity between them is still uncertain.

DOUGLAS's specimen was brought from the limestone developing at Qashgai Sarhad, 4 miles N.E. of Abadeh, the horizon of which is uncertain but may probably be the *Neoschwagerina* zone. (see P. 7 in DOUGLAS, 1950)

Ipciphyllum gnomeiense (HUANG)

1932 *Stylidophyllum gnomeiense* HUANG, p. 75, pl. 7, figs. 2a, b.
(non *Stylidophyllum gnomeiense*, HERITSCH 1939)

Holotype: Cat. no. 3879, Geol. Survey of China.
Type locality: Basal part of the Permian limestone of Gnomeishan, Szechuan, Loc. no. 1435.
Geological age: *Parafusulina* zone. Associated fossils are: *Wentzelella szechuanensis* Huang and *Hayasakaia nankingensis* (YOH).

Diagnosis: *Ipciphyllum* with simply constructed axial column, in which septal lamellae are wanting, and with less inclined clinotabulae, and without transverse tabulae.
Remarks: This species is characteristic in having a thin wall and fairly well developed lonsdaleoid dissepiments. Further, the axial column is composed of steeply ascending tabellae with a median plate but is lacking in radial lamellae. Also the tabulae are worthy of note in this species. They mostly incline from dissepimentarium towards the axis of the corallite at a 45° approx. angle. In addition, they are regularly spaced, and nearly complete. Further, they are not differentiated into two parts, viz. outer and inner tabulae.

In any event, they cannot be regarded as steeply inclined transverse tabulae but rather less inclined clinotabulae.

They do not incline as steeply as normal clinotabulae, which usually have a deep dip. In general, clinotabulae with low angles are found in more primitive forms in each bio-series belonging to Waagenophyllidae.

If the supposition is correct, that is to say, if the tabulae found in the present form are clinotabulae, transverse tabulae must be regarded to be lacking in the present species, or at least nearly obsolete.

Meanwhile, the presence of elongate dissepiments is doubtless in the present form, although they are smaller in size and developing at only narrow space of the innermost dissepimentarium.

Hence, the present form must be transferred from *Stylidophyllum* and can be placed with certainty into *Ipciphyllum*. Some forms of *Stylidophyllum* have incipient elongate dissepiments and clinotabulae, but they have broad and horizontal tabulae, instead of inclined tabulae as in the present form.

HERITSCH (1939) once placed his coral from Ala Dagh, Kilikis Tarus into the present species now in question. The coral from Turkey is apparently akin to *Ipciphyllum gnomeiense* HUANG in having a thin wall and considerably well developed lonsdaleoid dissepiments. However, the nature of axial column obviously differs between these two forms. As is clearly described and figured by HUANG, septal lamellae of the axial colum are entirely lacking in his species, but they are very well developed in HERITSCH's specimen.

We believe, the Turkey coral more nearly resembles "*Lonsdaleia*" *chaoi* var. described by HUDSON in 1958 from Northern Iraq, though the former may be still considered to be specifically distinct from the latter.

Ipciphyllum huangi nom. nov.

1932 *Wentzelella timorica*, HUANG, p. 58, pl. 3, figs. 4, 5, 6. (non *Lonsdaleia timorica* GERTH, 1921).
1961 *Wentzelella laosensis* PATTE var. *tenuis*, FONTAINE, pl. 177.
1961 *Wentzelella laosensis* var. *minor*, FONTAINE, pl. 21, figs. 6, 7.
1963 *Ipciphyllum irregulare* WU, p. 502, pl. 2, figs. 7–10. (non *Wentz. irregularis* FONTAINE).
Holotype: Catalogue nos. 14043, 14044, Inst. Geol. & Palaeont., Academia Sinica.
Type locality: Maokou suite, Ziyun district, Kueichow.
Geological age: *Parafusulina* to *Neoschwagerina* zone.

Specific diagnosis: *Ipciphyllum* with relatively small corallites, with rather thin wall, and with very narrow, sub-horizontal transverse tabulae but without lonsdaleoid dissepiments.
Remarks: In respect to the thickness of septa and size of axial column, the present form seems to be rather variable. However, the present form does not have so thick septa at walls as typical *Lonsdaleia timorica* described by GERTH from Timor, and is specifically distinct from the latter.

In this respect, the present form is more nearly akin to *Ipciphyllum subtimorica* but, the present form possesses a far narrower transverse tabulae than that of the latter.

In 1961 FONTAINE described some Laos coral under the name of *Wentzelella laosensis* PATTE var. *tenuis*, whereas he illustrated that coral under the name of *Wentzelella laosensis* PATTE var. *minor*. The mentioned Laos coral may be conspecific with the present form, because it is also free from lonsdaleoid dissepiments. In addition, the former is nearly the same with the latter in size of corallites and septal number.

Although the axial tabellae of the column in the Laos specimen seems to be apparently more steeply inclined than that of the Chinese specimens described by HUANG, it must be noted here that such difference may resulted from the different orientation of the sections. Actually, we can find no marked differences between Laos and Chinese specimens in this respect, if we compare the thin sections illustrated by FONTAINE (fig. 7) and the corallite figured by HUANG as fig. 6 on plate 3. Hence, we are led to believe that the mentioned Laos coral and Chinese coral described by HUANG may be entirely conspecific with the holotype of WU.

Ipciphyllum flexuosum (HUANG)

1932 *Wentzelella flexuosa* HUANG, p. 60, pl. 4, figs. 2a, b.
Holotype: Cat. no. 3863, Geol. Surv. China.
Type locality: Permian limstone, south of Tashihpa, Mienchuhsien, Szechuan, China.
Geol. Horizon: *Neoschwagerina* zone in rough estimation.

Specific diagnosis: *Ipciphyllum* with comparatively large corallites in which the calicular diameter occasionally reaches about 13 mm. Minor septa as long as the major ones but slightly thinner than the latter. No prominent lonsdaleoid dissepiments.

Ipciphyllum anatolicum (FLÜGEL)

1955 *Wentzelella anatolica* FLÜGEL, p. 305, pl. 35, fig. 10.
Holotype: Cat. no. 275, Geol. Inst. Graz Univ., paratype: no. 20133 of Meka, Ankara or 274 of Geological Inst. Graz.
Type locality: Locality 11, North Ala Dag.
Geological age: Perhaps the *Neoschwagerina* zone.

Specific diagnosis: *Ipciphyllum* with a narrow space occupied by transverse tabulae, with short minor septa and small axial column. Lonsdaleoid dissepiments poorly developed.
Remarks: This coral has fairly large corallites, the calicular diameter of which reaches in general 9.5 to 11.1 mm, but ranges from 15 to 20 mm at maximum. There are 16 to 17 major septa.

From the large sized corallites, the present form may be somewhat comparable to *Ipciphyllum flexuosum* HUANG, but it specifically differs from the latter in having less numerous septa. Further, the present form provides minor septa which are far shorter than that of the latter.

Although FLÜGEL did not illustrate the longitudinal section for the present form, clinotabulae may well develop in this form, according to his description, and transverse tabulae are assumed to be narrow. Thus, the present form seems also to akin to *Ipciphyllum huangi*, but differs from the latter in having far larger corallites in the present form.

Ipciphyllum simplex WU

1963 *Ipciphyllum simplex* WU, p. 502, pl. 2, figs. 3–4.

Holotype: Cat. nos. 14039 and 14040. Geol. and Palaeont. Inst. Academia Sinica.
Type locality: Heshan suite, Yishan district, Kwangsi. Ay 374.
Horizon: Later Permian, possibly *Neoschwagerina* or *Yabeina* zone.

Diagnosis: *Ipciphyllum* with relatively smaller corallites in which the transverse tabulae are rather narrow. The axial struiture is simply constructed. Clinotabulae and elongate dissepiments are well developed. Minor septa are fairly long.

Remarks: The present form resembles *Ipciphyllum irregulare* WU in many points. In the former, however, the axial structure is more simply constructed.

As stated by WU, the present species seems to also resemble *Ipciphyllum elegans* (HUANG) but is specifically distinct from the latter in having longer minor septa.

(Note on "*Ipciphyllum*" *tschernyschewi* MINATO)

The senior author once described a Permian cerioid coral from Ellesmereland as belonging to the Genus *Ipciphyllum* (1960).

The coral was originally described by TSCHERNYSCHEW and STEPANOV as a member of *Lithostrotion*.

But later investigation on this form reveals that the coral under consideration is neither *Ipciphyllum* nor *Lithostrotion*. It actually belongs to the group of Russian *Protowentzelella*, which is however, not a member of Waagenophyllidae, in spite of its generic name.

At the time when the senior author was engaged in the study of the said coral, he was unfortunately not able to obtain the original desdription of *Protowentzelella* in the work by SOSHKINA, DOBROLYUBOVA and PORFIRIEV (1941). Therefore, he could not but discuss the true kinship of Ellesmereland form in relation to hitherto known Tethyan forms.

The group of *Protowentzelella* is a fairly large one, spreading widely from North America over to the Urals in a region called "boreal sea" in the Permian. This group may be related to *Lithostrotion*, and not to waagenophyllids in the Tethyan sea.

Roughly speaking the age of the *Protowentzelella* fauna, however, corresponds to the *Parafusulina* zone. Therefore, the correlation table given by the author in showing the stratigraphical position of the bed containing "*Lithostrotion borealis*" needs not to be revised here.

Genus ***Paraipciphyllum*** WU, 1963

Type species: *Paraipciphyllum elegantum* WU, 1963.
1963 *Paraipciphyllum* WU, p. 496, 501.

Generic diagnosis (defined by WU) runs as follows: Corallum compound, massive, composed of numerous, regular polygonal corallites. Epitheca slightly curved, usually partly vanishing, corallites thus appearing confluent by septa. Septa few in number, of two orders. Columella thick, formed of concentric tabellae, a distinct median plate and a number of radiating lamellae. Dissepiments numerous. In longitudinal section, tabulae develop, almost horizontal or slightly sloping towards the center.

Discussions: Thus, WU defined the present genus to have no definite canals or gaps like *Parawentzelella* FONTAINE. Actually, he stated that the present form agrees fairly well with *Ipciphyllum* HUDSON 1958 in having rather few septa and in having the characteristics of columella and dissepiments, but differs from *Ipciphyllum* essentially in the partly vanishing of epitheca.

Nevertheless, WU included many other species into the newly proposed genus, which have, however definite canals. For instance, *Wentzelella cananlifera*, *W. socialis* and *W. paracanalifera* are in the present genus. Accordingly, the present genus seems to be synonymous with *Parawentzelella* FONTAINE. Further, it may be somewhat important that WU gave the diagnosis in Chinese, in which WU defined that there are always canals in the present genus.

However, we wish to place special stress on the fact that WU established the present genus on *Paraipciphyllum elegantum* WU as the type species among many other species. In the type species, no definite canals or gaps in the walls are discernible. As a matter of fact, in the type species of the present genus, the walls become locally thin and partly vanishing.

Accordingly, the present form would be generically best distinguished from both *Ipciphyllum* and *Parawentzelella* in losing of walls.

In this regard, we are reminded of certain species belonging to the genus *Szechuanophyllum* in which a similar tendency of partly vanishing walls is also recognizable.

However, the present genus is decidedly different from *Szechuanophyllum*, since the latter always possesses a higher order of septa and well developed lonsdaleoid dissepiments.

In the meantime, there is a species which has the same type of walls as the present genus but is provided with sporadically developed tertiary septa.

This is the coral called by HUDSON under the names of *Wentzelella canalifera* MANSUY and *W. socialis* MANSUY. Such corals are however neither generically

nor specifically identical with MANSUY's species from the view points above described.

The coral now in question is indeed difficult in settling its taxonomic position. In this regard we made lengthy discussions because the present species has a intermediate nature between *Wentzelella*, *Parawentzelella* and *Paraipciphyllum*.

If the presence of tertiary septa, though sporadically developed, is viewed to be important, the present species must be included into the genus *Wentzelella*. In spite of this, the general feature of corallites is rather akin to the genus *Parawentzelella*, except for the tertiary septa. At the same time, the present species seems also to be almost related to the genus *Paraipciphyllum*.

The presence or absence of tertiary septa is a very important criterion to distinguish the subfamily Wentzelellinae from Waagenophyllinae. However, we are finally inclined to admit the possibility that the present species might have evolved from a species such as the type species of the genus *Paraipciphyllum* by aquiring tertiary septa. That is to say, the species in question originally belonged to a different stock from *Wentzelella*, although they are provided with tertiary septa. Thus it would be better included into the genus *Paraipciphyllum* WU.

Therefore the generic diagnosis of *Paraipciphyllum* will be amended as follows: Cerioid Waagenophyllidae with or without tertiary septa, and relatively thick walls, which are occasionally, and partly vanishing, but without any definite canals such as those found in *Parawentzelella*. Lonsdaleoid dissepiments may develop to a slight degree.

Geographical distribution: Anhui, China and Northern Iraq.
Geological distribution: *Neoschwagerina* zone.

Included species: *Paraipciphyllum elegantum* WU
Paraipciphyllum hudsoni sp. nov.

Paraipciphyllum elegantum WU

1963 *Paraipciphyllum elegantum* WU, p. 501, pl. 1, figs. 1–5.
Holotype: Cat. nos. 14030–14034. Geol. and Palaeont. Inst. Academia Sinica.
Type locality: Maokou suite, Tongling district, Anhui.
Geological horizon: *Neoschwagerina* zone.

Paraipciphyllum hudsoni, nov.

1955 *Wentzelella canalifera*, HUDSON, p. 185, pl. 35, figs. 3, 5, 6, 7; text-fig. 3f. (non *Lonsdaleia canalifera* MANSUY, 1913).

1955 *Wentzelella socialis*, HUDSON, p. 185, pl. 34, figs. 3, 4; text-fig. 4b. (non *Lonsdaleia socialis* MANSUY, 1913).

Type: R. 42014 (nine pieces), R. 42013 (five pieces). British Museum (Nat. Hist.).

Type locality: *Wentzelella* limestone, Zinner limestone, Harrur section, Chalki, northern Iraq.

Geological horizon: *Neoschwagerina* zone.

Diagnosis: Cerioid Waagenophyllidae with sporadically developed tertiary septa and relatively thick walls which are occasionally interrupted by a partly losing wall, but without true canals. Lonsdaleoid dissepiment may develop to a certain degree.

Remarks: HUDSON once held a view that the present form might be referable to *Parawentzelella canalifera*. The form now in question indeed resembles the said species from the size of corallites, septal number and general mode of other sekeletons.

However, the present form has, according to HUDSON, no typical canals on walls, although the walls are locally suppressed to show a indefinite aphroid trend.

Moreover, the present form possesses rather thick walls and tertiary septa.

Although the tertiary septa in the present form are not well developed and are only locally found in certain corallites, especially at angles with corallites, the presence of tertiary septa does not permit the present form to be placed into *Parawentzelella* or *Ipciphyllum*.

Accordingly the present form would be best placed into the genus *Paraipciphyllum*, instead of possessing an apparent affinity to *Parawentzelella canalifera*.

As a member of *Paraipciphyllum*, the present form is somewhat characteristic in having less developed tertiary septa and showing local interruptions of walls.

The specimens described and illustrated by HUDSON also from Northern Iraq under the name of *Wentzelella socialis* (MANSUY) may be generically and specifically distinct from the typical species of MANSUY, because they have tertiary septa and are not provided with any typical canals.

The specimens, now in question, seem to be entirely the same with the specimens described by HUDSON as *Wentzelella canalifera* in size of corallites, septal number, length of septa etc.

Both of them (HUDSON's *canalifera* and *socialis*) possess with tertiary septa, although they are only sporadically developed. The slight difference between the two may be in the point of thickness of septa. In the specimens illustrated on plate 35 the septa are generally thick, especially near the wall and intrathecal area, while in the specimens figured on plate 34, the septa are thinner than that of the former, especially in the intrathecal area.

Yet, there are some corallites in which the reverse is the condition in concern to the above statement in each specimen figured on two plates.

Hence, the two forms having been distinguished as different species by HUDSON seem to us to be referable to a single species.

Genus ***Parawentzelella*** FONTAINE, 1961

1961 *Parawentzelella* FONTAINE
Wentzelella auct. (partim).
Type species: *Lonsdaleia canalifera* MANSUY, 1913.

Generic diagnosis: Cerioid Waagenophyllidae, in which tertiary septa are entirely lacking. Walls are generally thick. Lonsdaleoid dissepiments are in various degrees, while canals or gaps on walls are very prominent. Although elongate dissepiments are well developed, and clinotabulae also develop to some extent, transverse tabulae are rather wide.

Geological range: *Parafusulina* to *Yabeina* zone.
Geographical distribution: Japan, Indochina and China.

Subgenus ***Parawentzelella*** FONTAINE, 1961

Type species: *Lonsdaleia canalifera* MANSUY, 1913.

Subgeneric diagnosis: *Parawentzelella* without or almost lacking in lonsdaleoid dissepiments.
Included species: *Parawentzelella* (*Parawentzelella*) *canalifera* (MANSUY), 1931
Parawentzelella (*P.*) *canalifera* var. *sisophonensis* FONTAINE, 1961
Parawentzelella (*P.*) *socialis* (MANSUY), 1913
Parawentzelella (*P.*) *iwaizakiensis* (YABE et MINATO), 1945
Parawentzelella (*P.*) *gubleri* FONTAINE, 1961
Parawentzelella (*P.*) *regularis* FONTAINE, 1961

Remarks: *Parawentzelella* differs from *Ipciphyllum* in having slightly thicker wall and characteristic canals. The canals appear to develop in general at corners of angular corallite, where two or three neighbouring corallites meet together.

In fasciculate *Waagenophyllum*, laterally expanded supporting process is not commonly observed. But as far as the writers can see, the tube is always blind at the external end, so that it cannot be a connecting tube but a supporting process between corallites.

On the contrary, canals in *Parawentzelella* actually connect two corallites, starting from one tabularium to the other. Certainly they are not mere traces of symbiosis or some other phenomenon as HUDSON once mentioned. (1958, p. 185)

The senior author once described a cerioid Waagenophyllidae in which canals may have been the first step in the plocoidal trend in *Wentzelella* and allied forms

(MINATO 1955, p. 114): this view was however denied by FONTAINE (1961, p. 185). Indeed, the canal is more than a mere interruption or discontinuty of wall, as above stated.

Although the function of canals is not clear at the moment, we consider it justifiable to separate these corals which have canals from the true *Ipciphyllum* or *Wentzelella*.

Parawentzelella* (*Parawentzelella*) *canalifera (MANSUY)

1913 *Lonsdaleia canalifera* MANSUY, p. 109, pl. 11, fig. 12; pl. 12, fig. 1a–c.
1961 *Parawentzelella canalifera*, FONTAINE, p. 186, pl. 28, figs. 1, 2, pl. 29, figs. 4, 5. (non pl. 25, figs. 1, 3).
Non *Lonsdaleia canalifera*, SEN, 1931.
Non *Wentzelella canalifera*, HUDSON, 1958.
Holotype: no. 780, Musé du Service Geologique de Saigon.
Geological age: According to FONTAINE, *Yabeina-Lepidolina* zone, however HUDSON 1961 mentioned the age of the present species to be the *Neoschwagerina* zone (p. 186).
Distribution: Laos and Cambodge.

Remarks: Whether the specimens given by FONTAINE in 1961 on his plates 25 and 28 are really specifically identical to the holotype specimen given also by FONTAINE on his plate 29 was at first a problem for us. Because in the holotype, the wall always appears to be thick and regularly flexuous or zig-zagging in the cross section, and perfectly septate at all peripheries of the corallites. Further the minor septa are short. Whlle in other specimens illustrated by FONTAINE on plates 25 and 28 to which he geve also the same name, walls are in general irregularly thick viz. some of the corallites have very thin and nearly straight walls in the cross section besides the peripheral zone is occasionally non-septate and minor septa are considerably long. After a long discussing, however we came to conclude that the specimens given by FONTAINE as figs. 1, 2 on plate 28 may be more nearly akin to the holotype of the present species than the other specimens illustrated by him on plate 25 (figs. 1, 3) and may be regarded to be specifically almost identical. But, the specimens (figs. 1, 3 on plate 25) would be better transfered from the typical *canalifera* and placed into var. *sisophonensis*. SEN (1931) described *Lonsdaleia canalifera* from the Salt range. But his specimen actually has a dense column, tertiary septa and walls, which are thick but sometimes discontinuous. Hence SEN's specimen is close to the *Wentzelella salinaria* group as it will be stated later on, though it tends to become Lonsdaleiastraeimorph.

HUDSON also described the same species from North Iraq in 1958, however, his specimen has tertiary septa, though they are only sporadically developed. Further he considered canals are communications between corallites. We cannot but disagree with HUDSON's in this regard.

Parawentzelella (*Parawentzelella*) *canalifera* (MANSUY) *sisophonensis* FONTAINE

1961 *Parawentzelella canalifera* var. *sisophonensis*, FONTAINE, p. 190, pl. 25, figs. 2, 4; pl. 26, figs. 2, 3, 4, 6.
1961 *Parawentzelella canalifera*, FONTAINE, pl. 25, figs. 1, 3 (non *Lonsdaleia canalifera* MANSUY, 1913).
Syntype: 707–710, 712. FONTAINE's collection.
Type locality: Not defined. Localities are Phom, Tup, Phnom Banteay Neang, Phnom Kdong, Phnom Angkor and Phnom Takream, all in Cambodge.
Geological age: "Kazanian", *Yabeina-Lepidolina* zone.

Remarks: The present form may be distinguishable from the typical *canalifera* by the slight difference in construction of the axial column. As it was stated by FONTAINE, the axial column of the present form is characteristic in having less numerous septal lamellae with an irregular arrangement. In addition, the present form also differs from the latter in irregular thickness of wall.

The specimens given by FONTAINE as the typical *canalifera* on his plate 25 as figs. 1, 3 appear to be akin to *canalifera* in the construction of axial column, yet they can be placed into the present variety because of their irregular thickness of the wall.

Parawentzelella (*Parawentzelella*) *socialis* (MANSUY)

1913 *Lonsdaleia socialis* MANSUY, p. 110, pl. 1c, fig. 2.
1932 *Wentzelella paracanalifera*, HUANG, p. 63, pl. 5, figs. 2a, 2b.
1961 *Parawentzelella socialis*, FONTAINE, p. 190, pl. 26, figs. 5, 7; pl. 28, fig. 3.
Non *Wentzelella socialis*, HUDSON, 1958.
Holotype: No. 783 musee du Service Geologique de Saigon.
Type locality: Phnom Takream, Cambodge.
Geological age: FONTAINE stated the age to be the *Lepidolina* zone, but according to HUDSON, 1961 (p. 186), it may be the *Neoschwagerina* zone. Further Chinese form probably comes from *Parafusulina* zone.

Remarks: The present form can hardly be distinguished from *Parawentzelella canalifera* (MANSUY) in the size of corallites, septal number or nature of axial column. However, the present form possesses a thicker wall which is strengthened by thicker septa, especially near the walls.

HUDSON's form from Iraq does not appear to have canals on its walls, hence, it cannot be classified as *Parawentzelella*.

So-called *Wentzelella paracanalifera* described by HUANG from Chinese Chihsian seems to be hardly distinguishable from the present form, although canals are more prevalent in the former than the latter according to HUANG.

Parawentzelella* (*Parawentzelella*) *iwaizakiensis (YABE et MINATO)

1945 *Wentzelella iwaizakiensis* YABE et MINATO, p. 469, text-fig. 1–5.
1955 *Wentzelella iwaizakiensis*, MINATO, pl 110, pl. 20.
Type specimen: Geological and Palaeontological Institution, Tohoku University, Sendai, Japan.
Type locality: Iwaizaki, Miyagi Prefecture, Japan.
Geological age: *Neoschwagerina* zone (see also chapter on stratigraphy).

Remarks: This species is characteristic in lacking tertiary septa and having a considerably thick wall as a whole. But this species appears to resemble *Parawentzelella canalifera* or *socialis* to a certain degree. Yet the present form has smaller corallites and decidedly fewer septa in comparison with the latter two. Further, the septa of the present form are somewhat curved and not straight near the wall and are different from the septa observed in the holotype of *Parawentzelella canalifera* given by FONTAINE on his plate 29.

From the typical form of *canalifera* this species may be distinguishable by its wider tabularium with nearly horizontal or only slightly inclined transverse tabulae and less developed elongate dissepiments.

Parawentzelella* (*Parawentzelella*) *gubleri FONTAINE

1961 *Parawentzelella gubleri* FONTAINE, p. 191, pl. 28, fig. 4; pl. 31, fig. 9; pl. 34, fig. 7.
Holotype: GUBLER collection, No. F. 194.
Type locality: Unknown, but somewhere in Cambodge.
Geological age: May be the Upper Permian.

Remarks: The species very closely resembles *Parawentzelella socialis*. The former has, however, a loosely constructed axial column and slightly thinner walls in comparison to the latter.

Parawentzelella* (*Parawentzelella*) *regularis FONTAINE

Pl. 13, figs. 4–6; Text-fig. 5 b.

1961 *Parawentzelella regularis* FONTAINE, p. 192, pl. 28, figs. 9–10; pl. 30, fig. 8; pl. 31, fig. 8.

Holotype: F. Bonell; coll. F. 189–192.
Type locality: Unknown, but somewhere in Sisophon region, Cambodge.
Geological age: *Neoschwagerian* zone.

The Japanese specimens newly obtained will be described in the following: Corallum cerioid, corallites rather small, whose general diameter attains only 4.0 to 4.5 mm in the full grown stage. Walls are considerably thick, especially in the corallites showing the earlier stage of ontogeny. As a matter of fact, the wall is composed of thin black line in the medial zone in the cross section, which is strengthened by translucent deposits. The black line shows a zig-zagging or flexuous in most corallites and is rarely straight in the cross section.

Septa are also very thick at walls, then decrease rapidly in thickness towards the axial ends. The minor septa alternating with the major ones are rather long, reaching approximately 2/3 the length of the latter. Septa are almost always continuous, but only rarely become discontinuous in the peripheral area where lonsdaleoid dissepiments with low convexity begin to appear to some extent. Nevertheless, there are no remarkable non-septate zones in almost all the corallites observed.

Columela is small in size, and only loosely constructed by axial tabellae which are somewhat concentric in arrangement, and has less numerous and sporadically disposed septal lamellae, in which no distinct median plate is discernible, although not entirely lacking.

Septa are normally quite free from columella, but counter septum sometimes unites with the outermost axial tabellae. However, the counter septum does not directly unite with the median plate.

Canals are locally well developed, especially at the corners where three neighbouring corallites meet with their walls.

In the longitudinal section, elongate dissepiments and clinotabulare are well developed. Yet, transverse tabulae are by no means narrow.

Dimensions of corallites are as follows:

size	septal number	axial structure
1.0~2.0 mm	6~ 5	non
2.5~3.5	9~ 8	median plate plus single axial tabellae
2.5~3.5	10~10	median plate with two layered axial tabellae
4.0~4.5	13~13	four layered axial tabellae and five septal lamellae
4.0~4.5	14~14	five layered axial tabellae and eight septal lamellae

Remarks: The present species may be closely allied to *Parawentzelella socialis* but possesses smaller corallites in general and relatively longer minor septa. Further, columella is much narrower in this species than *socialis*. Hence, it may be specifically independent from the latter.

The Japanese form now in question, which may be conspecific with the

FONTAINE's species called *regularis* was collected from the limestone cropped out at Iwaizaki, Kitakami mountains. The age is certainly the *Neoschwagerina* zone.

Our repository: Reg. nos. 18427–18429; 18250–18254. Iwaizaki, Hajikami, Kesennuma city Miyagi Prefecture.

Subgenus ***Miyagiella*** nov.

Type species: *Parawentzelella* (*Miyagiella*) *miyagiensis* sp. nov.

Subgeneric diagnosis: Walls are thin or thick. Lonsdaleoid dissepiments are well developed.

Included species: *Parawentzelella* (*Miyagiella*) *miyagiensis*, sp. nov.
Parawentzelella (*Miyagiella*) *motoyoshiensis*, sp. nov.

Age: *Neoschwagerina* zone.
Geographical distribution: Japan.

Parawentzelella* (*Miyagiella*) *miyagiensis, sp. nov.

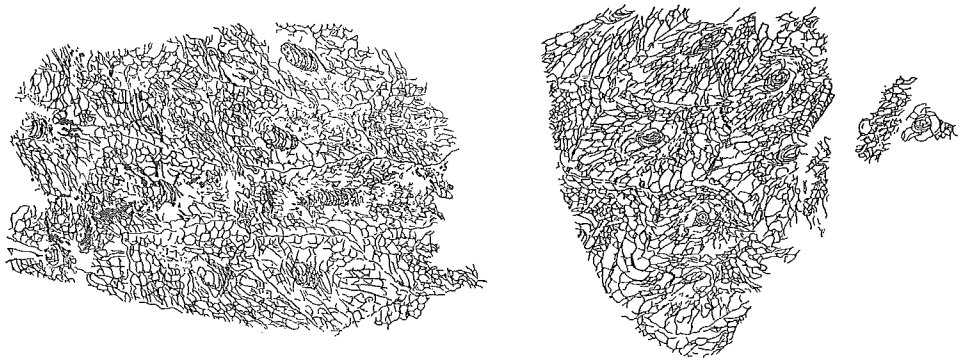
Pl.1, figs. 2, 4; Pl. 13, figs. 1–3;
Text-figs. 53–54.

Corallum compound, massive and composed of irregularly polygonal corallites, being approximately 5 mm in average diameter. Walls thin, straight, little curved, slightly flexuous or weakly zig-zagging in the cross section. Walls are not provided with definite translucent layers in the middle portion, but are composed of black layers provided with no remarkable deposits.

Septa are thin, slightly wavy or flexuous in the cross section. A local thinning out in the peripheral area is seen which is replaced by a number of lonsdaleoid dissepiments. The septa are of two orders. Fifteen major septa were counted, alternating with the same number of minor ones which are a little shorter than the former. Further, the minor septa mostly tend to grow from the inner wall instead of the outer wall.

Columella is very small, and loosely constructed, which comprises a few layers of axial tabellae and very sporadically disposed short and slender lamellae, in which no distinct median plate is discernible.

Lonsdaleoid dissepiments are irregular in size and form, which occupy a large area in the peripheral zone of almost all of the corallites observed. The boundary between the area occupied by lonsdaleoid dissepiments and that of the elongate dissepiments is nearly always sharply defined by the inner wall which is pronounced by the outermost layer of elongate dissepiments and provided with ends



Text-figure 53

Parawentzelella (*Miyagiella*) *miyagiensis* MINATO et KATO, sp. nov. (×2.2); Iwaizaki, Kesennuma city, Miyagi Prefecture. *Neoschwagerina* zone. UHR 18273.

Text-figure 54

Parawentzelella (*Miyagiella*) *miyagiensis* MINATO et KATO, sp. nov. (× ca. 6.5); Iwaizaki, Kesennuma city, Miyagi Prefecture. *Neoschwagerina* zone. UHR 18274.

of minor septa.

The canals are found at the angles where the neighbouring corallites meet with their walls. The canals are narrow in general and are built by a partial loss of the wall. They unite with septa of the neighbouting corallites, which bring forth a narrow passage between the corallites.

In the longitudinal section, lonsdaleoid dissepiments occupy a large area in most corallites observed, while the elongate dissepiments are not well developed, although their presence is doubtless. Clinotabulae are mostly not strongly inclined and directly unite with transverse tabulae by their inner margins. The transverse tabulae are rather wide and not densely distributed. Columella is very narrow.

Remarks: This species is characteristic in having extremely prominent lonsdaleoid dissepiments.

Repository: U. H. Reg. nos.: 18272–18274 (holotype), 18245–18246, 18219–18221.
Iwaizaki, Hajikami Motoyoshi, Kesennuma city Miyagi Prefecture.
Horizon: *Neoschwagerina* zone.

Parawentzelella* (*Miyagiella*) *motoyoshiensis, sp. nov.

Pl. 7, fig. 1; Pl. 14, figs. 1–5.

Corallum is cerioid, corallites are irregularly polygonal, mostly are small with a maximum width generally not exceeding 5 mm. The walls are considerably thick. In the cross section median black line is observable in the middle zone, which is rarely straight or sub-straight but mostly zig-zag or is irregularly flexuous. The black line is thickly decorated by translucent deposits on both sides.

As many as 14 or 13 major septa are counted in the ephebic stage, which alternate with the same number of minor ones. The septa are thick, and of the diffuso-trabecular type. They are not always straight in the cross section, but are sometimes irregularly curved, flexuous or zig-zag. They grow from the wall in general but the peripheral area is locally non-septal, where lonsdaleoid dissepiments develop in various degrees. The lonsdaleoid dissepiments are irregular in size and locally flat with low convexity, or sometimes irregular convex. Major septa almost reach the axial strucure in general, though they do not directly penetrate into the columella. While, the minor septa are always far apart from the axial structure. Canals are very prominent, though not wide, which are especially distinct at the corners of corallites, where the three neighbouring corallites meet together.

The axial structure occupies a rather narrow space, the diameter of which is generally less than one third the length of the calicular diameter. The median plate is occasionally prominent, though not particularly thick or long. The outer columella is rather densely constructed in the cross section by numerous but short and slender septal lamellae and closely set several layers of axial tabellae, being somewhat concentric in disposition. While the inner part of columella is generally well spaced, where only a few axial tabellae are developed except for the occasional presence of a median plate.

In the longitudinal sections, lonsdaleoid dissepiments of unqeual size are observable in the peripheral area. Large and small elongate dissepiments are arranged in a few rows, immediately outside of the tabularium. Then clinotabulae are disposed, with their inner ends united with transverse tabulae. Transverse tabulae are rather broad, and generally flat or faintly concave downwards, or inclined outwards.

The axial column is composed of flat tops or only little up arching tabellae in which a discontinuous median plate is locally discernible. The tabellae are

very steep on both sides where they are closely set and inosculating with each other.

Remarks: The present form differs from the preceding species in having thick walls and thick septa. Also, lonsdaleoid dissepiments are slightly less developed in the present form than the type species of *Miyagiella*.

Reg. nos: U.H.R. 18232–18236 (Holotype), 18237–18238, 18241–18243, 18239–18240.
Locality: Iwaizaki, no. 10, Motoyoshi, Kesennuma city, Miyagi Prefecture.
Horizon: *Neoschwagerina* zone.

Subfamily **Wentzelellinae** HUDSON

Dianosis. Waagenophyllid corals with septa of three or more orders. Elongate dissepiments, clinotabulae, and lonsdaleoid dissepiments may develop in various degrees.

(I. **Solitary forms**)

KEY TO SPECIES BELONGING TO SOLITARY FORMS

Tertiary septa present.....Genus *Iranophyllum*
  lonsdaleoid dissepiments absent, septa straight, sometimes vesicular. Clinotabulae distinct. .....Subgenus *Iranophyllum*.
    axial column weakly constructed
      septa numerous .....*I. indicum* (DE KONINCK)
      septa less numerous .....*I. splendens* DOUGLAS
    axial column rather packed, septa thick.....*I. tunicatum* IGO
    axial column densely constructed .....*I. amygdalophylloideum* (HUANG)
  lonsdaleoid dissepiments present .....Subgenus *Laophyllum*
    axial column not compact, lonsdaleoid dissepiments well developed
      .....*I.* (*L.*) *pongouaense* (MANSUY)
    axial column rather compact, tertiary septa long.
      with smaller corallite.....*I.* (*L.*) *nakamurai* nov.

Genus ***Iranophyllum*** DOUGLAS, 1936 emend.

Type species: *Iranophyllum splendens* DOUGLAS, 1936.

Generic diagnosis: Solitary Waagenophyllidae with tertiary or more orders of septa. Lonsdaleoid dissepiments often develop in various degrees.

Geologic distribution: Permian (*Pseudoschwagerina* to *Yabeina* zone)
Geographic distribution: Iran, Baluchistan, Pakistan, Viet-Nam, South China and Japan.

Subgenus ***Iranophyllum*** DOUGLAS, 1936

1936 *Iranophyllum* DOUGLAS (partim), p. 17.
1940 *Iranophyllum*, SMITH (partim), pp. 4–5.
1950 *Iranophyllum*, DOUGLAS (partim), pp. 16–17.
1950 *Iranophyllum*, WANG (partim), p. 211.
1956 *Iranophyllum*, HILL (partim), F. 309.
1961 *Iranophyllum*, FONTAINE (partim), pp. 193–194.
Type species: As for genus.

Subgeneric diagnosis: Corallum simple. Dissepimentarium is fairly thick with well developed dissepiments, and large elongate dissepiments. No lonsdaleoid dissepiments are seen. Septa in three or more orders, crenate, perforate, with or without carinae or carinae like process, sometimes vesiculate. Axial column rather small, somewhat solid in earlier form, while densely or loosely constructed by lamellae and tabellae in the latter forms.
Included species:

Iranophyllum (*Iranophyllum*) *indicum* (DEKONINCK)
Iranophyllum (*Iranophyllum*) *tunicatum* IGO
Iranophyllum (*Iranophyllum*) *splendens* DOUGLAS
Iranophyllum (*Iranophyllum*) *amygdalophylloideum* (HUANG)

Iranophyllum (***Iranophyllum***) ***indicum*** DEKONINCK

1863 *Clisiophyllum indicum* DEKONINCK, p. 3, pl. 2, fig. 4.
Holotype: Roy. Scot. Mus. 1871. 1. 44. FLEMING collection.
Type locality: Panjaub, Salt range, Pakistan.
Geological age: DEKONINCK (1863) threw some question upon the age of Salt range fossils which were then considered to be Carboniferous, because he found some "*Ceratites*" among the fauna. Anyhow, at present, it may be quite safe to say that the species now in question is Permian.

Remarks: The present species has long been ignored by workers, partly because of the inadequacy of the original description, and partly because of the doubtful assumption as to its age with regard to the Carboniferous. Also FLEMING's materials are generally thought to be not traceable.

Based on the information given by Dr. WATERSTON of the Royal Scottish

Museum of Edinburgh, the junior writer had the opportunity of examing the type specimen housed in the FLEMING collection when he visited Edinburgh in 1960.

The specimen, which is a cylindrical mature corallite, is in good accordance with DEKONINCK's figure and description. Although no thin sections are available, tertiary septa are clearly recongnizable on the fractured surface of the corallite. Major septa are about 40 in number and the shorter diameter of the corallite is about 4 cm. There is no sign of the development of lonsdaleoid dissepiments recognizable. There is absolutely no doubt that the species is *Iranophyllum*, and is the oldest described, the largest ever known specimen belonging to *Iranophyllum splendens* group, if not conspecific with the latter.

Iranophyllum* (*Iranophyllum*) *splendens DOUGLAS

1936 *Iranophyllum splendens* DOUGLAS, p. 18, pl. 1, figs. 4, 4a, 5.
1940 *Iranophyllum splendens*, SMITH, p. 5, pl. 1, figs. 8–9.
1950 *Iranophyllum splendens*, DOUGLAS, p. 20.
1961 *Iranophyllum splendens*, FONTAINE, p. 194.
Holotype: Slide S.P.R. 829.
Type locality: Tapileh valley, Darreh Duzdun, Iran.
Geological age: In the type locality the species is only associated with *Pavastehphyllum carcinophylloides*, so the exact age of the holotype cannot be said to be more than Permian. However the same species in South Iran seems to have been collected from the *Polydiexodina* zone, according to DOUGLAS (1950, p. 8). From northern Iraq HUDSON reported *Polydiexodina persica* KAHLER, and *Parafusulina kattaensis* from the horizon below the bed containing "*Lonsdaleia*" *chaoi* HUANG var, and "*Waagenophyllum indicum*" var. If we were to assume that the said *Polydiexodina* horizon can be correlated to the *Polydiexodina* bed in South Iraq, *Iranophyllum* (*Iranophyllum*) *splendens* may be regarded to denote the *Parafusulina* zone in our sense, because in Northern Iraq, HUDSON described many corals of Chihsian type including "*Wentzelella*" *canalifera*, "*W.*" *socialis*, *Wentzelophyllum persicum*: "*Ploythecalis*" *japonica*, *Ipciphyllum elegans* etc. from the *Wentzelella* limestone lying on the "*Lonsdaleia*" *chaoi* bed. Remarks under *Pavastehphyllum carcinophylloides* are also referred to.

Remarks: FONTAINE (1961) described this species from "Kungruian" of Viet-Nam (Massive of Bac-Son). The horizon is in fact the *Neoschwagerina* zone. He illustrated the specimen as *Iranophyllum* sp. (pl. 12, figs. 4a, b) without description. From Phom Takaream, Cambodge he also has a specimen which appears to be *Iranophyllum splendens*, which is said to have come from "Kazanian" (= *Yabeina* zone in our understanding).

We also consider *Cyathophyllum* cf. *multiplex* de KEYSERLING described and figured by MANSUY (1913) from Indochina to be identical with *Irano.* (*Irano.*) *splendens*, as DOUGLAS (1936) and FONTAINE (1961) have already pointed out.

From Japan, *Iranophyllum* cfr. *splendens* was once listed by MORIKAWA & others (1958) in the Iwaizaki limestone. One of the writers collected some specimens of *Iranophyllum* from the same limestone recently, and found that they are more close to *Iranophyllum tunicatum* than to *Iranophyllum splendens*.

Iranophyllum* (*Iranophyllum*) *tunicatum IGO

Pl. 15, figs. 2–5.

1959 *Iranophyllum tunicatum* IGO. p. 82, pl. 8, figs. 1a, b; Text-fig. 1.
Holotype: Tokyo Univ. of Education, no. 21015.
Type locality: Osobudani, Fukuji, Kamitakara-mura, Yoshiki-gun, Gifu Prefecture, Japan.
Geological age and associated fossils: *Pseudofusulina* zone, in association with *Pseudofusulina duplithecata* IGO, *Pseudofusulina* spp., *Nankinella kotakiensis* (FUJIMOTO et KAWADA) and *N. kawadai* (IGO).

Remarks: As it is commonly observed in all species belonging to *Iranophyllum*, this species also has septa with carinae or carinae like processes. Thus, the feature cannot be said to be characteristic of this species as IGO advocated. Except for the more complex nature of its axial structure, the species closely resembles the genotype of *Iranophyllum*.

It is noteworthy however, that this species shows a somewhat vesicular feature in its thick major septa, the character of which is a common nature in the *Pavastehphyllum spongifolium* group.

Other than the holotype we have several fragmental specimens from the Iwaizaki limestone cropping out at Iwaizaki, in the Southern part of Kitakami mountains at our disposal (U.H.R. 18261–18271). The Iwaizaki specimens were collected by Dr. Y. HASEGAWA and the junior writer from the limestone, which conformably overlies the *Monodiexodina matsubaishi* shale and is overlain by black *Yabeina* limestone. Hence the age of these corals, should be regarded to represent the *Neoschwagerina* zone, although no *Neoschwagerina* have been found from the said part of the limestone.

The specimens are large, having numerous septa including tertiary and even quaternary ones. Major septa are thick and somewhat vesicular in appearance. Lonsdaleoid dissepiments are absent. Axial column is fairly densely constructed. Rejuvenescence is observed.

In these general characters, the specimens may well belong to *Irano.* (*Irano.*) *tunicatum* as its larger variety.

As they represent a somewhat later form of the holotype of *tunicatum*, the specialization might have taken place in the development of quaternary septa and the increase in size of corallite and the number of septa, in Iwaizaki specimens.

Iranophyllum (*Iranophyllum*) *amygdalophylloideum* (HUANG)

1932 *Lophophyllum amydalophylloidea* HUANG, p. 31, pl. 2, fig. 13 ; pl. 16, fig. 7.
1933 *Amygdalophyllum nantanese* HUANG, p. 115, pl. 1, figs. 2, 2b.
Non *Sinophyllum? nantanense* YÜ, 1934, pp. 58–59, pl. 10, figs. 4–5.
Holotype : No. 3846 V. K. TING collection.
Type locality : Between Weng-ch'eng-ch'iao and Tsung-pa chieh, Kuei-ting-hsien, Kueichow, China.
Geologic horizon and associated fossil : The species was found together with *Waagenophyllum wengchengense*. The age is not correctly known, but may be the " *Wentzelella timorica* " zone according to HUANG (1932 b) (Upper *Parafusulina* zone).

Remarks : Although the axial column is densely constructed in this species, septal lamellae and axial tabellae are clearly differentiated in it, and moreover there are distinct tertiary septa in the coral. In the longitudinal section, also clear elongate dissepiments and clinotabulae are discernible.

Taking these points into account, the species should be better assigned into genus *Iranophyllum* s. str. The holotype may represent the late neanic or early ephebic stage judging from septal numbers and the mode of development of dissepiments.

As regards the dense axial column and comparatively thin septa, *Amygdalophyllum nantanense* HUANG from the Maping limestone of northern Kuangsi is specifically identical with *Iranophyllum* (*Iranophyllum*) *amygdalophylloideum*, although the former represents a mature stage.

Therefore the species ranges from *Pseudoschwagerina* to *Parafusulina*? zone.

Subgenus *Laophyllum* FONTAINE

1961 *Laophyllum* FONTAINE, p. 195.
Type species : *Chonaxis pongouaensis* MANSUY, 1912.

Diagnosis : *Iranophyllum* with well developed lonsdaleoid dissepiments. Original diagnosis given by FONTAINE is as follows : Poypiers simples, coniques, qui présentent-beaucoup d'affinitiés avec le genre *Iranophyllum* DOUGLAS, mais s'en distinguent par des septes disparaissant à la périphérie dans le dissépimentarium.

Geologic distribution : Permian (*Pseudoschwagerina* to *Neoschwagerina* zone).
Geographic distribution : Laos and Japan.

Included species : *Iranophyllum* (*Laophyllum*) *pongouaense* (MANSUY) 1912 and *Iranophyllum* (*Laophyllum*) *nakamurai*, sp. nov.

Remarks: At present, we know only the two species cited above which may be assignable with certainty into this subgenus. Of them, the older species *nakamurai* is distinct in its degree of development of elongate dissepiments from the younger *pongouaense*. The former has a rather smaller sized elongate dissepiment, occupying a very narrow area. On the contrary, the latter species possesses larger elongate dissepiments besides smaller ones together with longer clinotabulae, although both species have globose and lonsdaleoid dissepiments which are considerably well developed. The well developed lonsdaleoid dissepiments of the subgenus *Laophyllum* which is one of the solitary forms of the waagenophyllid coralls may be worthy of note. Here we are disregarding fasciculate and massive forms for a while, the above is said because lonsdaleoid dissepiments shows a definite decreasing and disappearing trend in the tracing from the geologically older species among the solitary forms towards younger forms of waagenophyllids. Thus it is noted here that the well developed dissepiments may be one of the evolutionary trends.

Meanwhile in the *Laophyllum*, species which are stratigraphically higher than the *Neoschwagerina* zone still possess very well developed lonsdaleoid dissepiments. In fact, the earlier species possess only smaller sized lonsdaleoid dissepiments, while the stratigraphically later species has large sized lonsdaleoid vesicles, besides smaller ones. Accordingly *Laophyllum* seems to be quite in comparison to the other solitary forms, although only two species in the present subgenus are known, and accordingly can not be said to be conclusive.

Iranophyllum* (*Laophyllum*) *pongouaense (MANSUY)

1912 *Chonaxis pongouaensis* MANSUY, p. 8, pl. 1, figs. 1a–c.
1961 *Laophyllum pongouaense*, FONTAINE, p. 196, pl. 9, fig. 3; pl. 33, fig. 6.
Non *Chonaxis* cfr. *pongouaensis*, REED, 1930, pp. 5–6, pl. 4, figs. 4, 4a.
Holotype: MANSUY collection, Musee Paleontologique de Ecole des Mines de Paris.
Type locality: Pong-Oua, near Luang-Prabang, Laos.
Geological age: *Neoschwagerina* zone.

Remarks: REED (1930) described *Chonaxis* cfr. *pongouaensis* from Tibet. Judging from his illustration of the specimen MANSUY's species, however, the coral seems to have a somewhat vesicular major septa, marked clinotabulae, and no lonsdaleoid dissepiments. It appears to belong to *Pavastehphyllum spongifolium* group.

Iranophyllum* (*Laophyllum*) *nakamurai sp. nov.

Pl. 15, figs. 1a–f.

Diagnosis: *Laophyllum* provided with comparatively small corallite, dense axial

column and long tertiary septa.

Description: Corallum simple, trochoid. Fine transverse striations are observed on the weathered surface of the corallite.

The axial column is large, well differentiated from the tabularium with somewhat thick stereoplasmic deposits on it. The column is polygonal in its outline and is composed of a medial plate, four septal lamellae on each side of the former plate, and numerous axial tabellae. The size of the axial column is about 4 mm along its shorter diameter in a full grown stage.

Septa are in three orders. Roughly speaking they are of diffuso-trabecular type under microscope. Majors are thick within tabularium but become thinner in dissepimentarium. Further, they become sinuous, carinated and then split into fine dot like structure in places where lonsdaleoid dissepiments develop. The numbers of major septa and the sizes of corallite in developmental stages are tabulated below.

18 mm	28 major septa
12 mm	24
5.5 mm	18?

Major septa extend almost to the outer margin of the axial column. Minor septa are rather short, alternate with the major, extend only as half the width of tabularium. Tertiary septa are clearly differentiated, rather long, and have nearly the same length with the minor.

Tabularium is wide, has 9 mm in its shorter diameter in full grown corallite. Only a few cut edges of tabulae are seen between septa in the tabularium. Inner wall is distinct by which the tabularium is bounded from the dissepimentarium.

Dissepimentarium is very wide, consists of narrow inner part of concentric dissepiments and wide outer portion of lonsdaleoid dissepiments. Lonsdaleoid dissepiments are remarkably well developed. They are comparatively small in size, globose but occasionally become large.

Epitheca thick, composed by fibrous tissues. Rejuvenescence may be recognizable because of the presence of the double wall feature outside of epitheca.

Three transverse sections are prepared in order to study ontogenetic development of the internal skeletal features of the coral. The youngest stage shows a somewhat triangular outline, has a 3.3 mm diameter, is badly recrystallized, and almost no significant internal structures are left. The second stage has a 5.5 mm diameter, in which axial column and dissepiments are already introduced. Major septa are about 18 in number, alternate with the minor, but no tertiary septa are discernible. This stage may indicate the middle neanic stage of the ontogeny of the coral. In the third stage the diameter of corallite reaches about 12 mm, in which the axial column becomes large, and tertiary septa and lonsdaleoid dissepi-

ments are seen. This may be late neanic to early ephebic stage. In the full grown stage the corallite attains as long as 18 mm in its shorter diameter, and has every ephebic features as above enumerated.

In the longitudinal section of the ephebic part of the corallum, a densely packed axial column composed of steeply arched axial tabellae is observed. Clinotabulae are only detected at the left hand corner of the tabularium. Dissepimentarium consists of steeply inclined dissepiments. Fine dot like projections are observed on dissepimental plates, and they may correspond to the dot like continuation of septal deposits in the transverse section. Dissepiments are becoming shorter and steeper as they approach the inner or the outer margins of the dissepimentarium. Calyx must be very deep, since there is no tabulae seen between axial column and dissepimentarium in this longitudinal section of the distal part of the corallum.

Remarks: Except for the present form, only *Laophyllum pongouaense* has been known to belong to the subgenus. The latter was reported to occur in the *Neoschwagerina* zone of Laos, while the former was obtained from *Pseudoschwagerina* limestone of Japan. The present form provides a comparatively smaller corallite, fewer septa, complicated axial column, and longer minor as well as tertiary septa in comparison with *Laophyllum pongouaense*, and is easily distinguishable from the latter. If the assumtion that *pongouaense* was derived from *nakamurai* is allowed, the process could be that the axial column became loose; peripheral parts of septa were largely replaced by lonsdaleoid dissepiments; the size of corallite was getting large; the number of septa was increased.

From the size of corallum, the mode of tertiary septa, the loosely constructed axial column and the number of septa, the present form resembles *Iranophyllum splendens*. But the former has well developed lonsdaleoid dissepiments which are recognizable even in neanic stage. Thus, these two are different species. However, it cannot be denied that the subgenus *Laophyllum* with the earliest known form of *I.* (*L.*) *nakamurai*, the present new form, was differentiated from *Iranophyllum* s. str. with tertiary septa by the strong development of lonsdaleoid dissepiments in times as early as the *Pseudoschwagerina* zone.

Material: Single corallite from *Pseudoschwagerina* limestone at Iwahatazawa, Yukisawa, Rikuzen Takata City, Iwate Prefecture. The specimen was found, in situ, in the fossil band almost exclusiverly of *Pseudoschwagerina* other than this single corallite.

Holotype: U.H.R. 18255–18260 (six thin sections) Coll. by Dr. K. NAKAMURA.

(Note on a Chinese Middle Carboniferous Coral)

CHI (1935) established a new species of what he considered to belong to genus *Amygdalophyllum* from the Weiningian, middle Carboniferous of China. But his

figure 4 on plate 2 of this species clearly shows the presence of small, lonsdaleoid dissepiments, tertiary septa and an axial column with tabellae and lamellae. Therefore it looks, as far as the characters revealed in cross section are concerned, like a species of *Iranophyllum* (*Laophyllum*) here defined, and not a *Amygdalophyllum*.

However, since CHI did dot mention or illustrate longitudinal characters of this species, the exact systematic position of the present form cannot be settled at the present moment.

Its occurrence in middle Carboniferous also makes us hesitate to assign it into *Iranophyllum* (*Laophyllum*), a Permian genus.

Also, there is possibility that the form is a member of Carboniferous Geyerophyllidae with development of tertiary septa, and septal lamellae and axial tabellae in axial structure.

It seems to be unwise for us to state our final opinion on the systematic position of this species of CHI, until its longitudinal characters are fully investigated.

(II. Fasciculate forms)

Gunus ***Praewentzelella*** nov.

Type species: *Waagenophyllum magnificum* DOUGLAS, 1936.

Generic diagnosis: Fasciculate Waagenophyllidae having tertiary, and quaternary septa.
Geologic distribution: *Pseudofusulina* to *Neoschwagerina* zone.
Geographic distribution: Turkey, Iran and Japan.

Included species: *Praewentzelella magnifica* (DOUGLAS), 1936
Praewentzelella multiseptata (ENDERLE), 1904
Praewentzelella honjoi nov.

Remarks: Existence of tertiary septa in fasciculate Waagenophyllidae was already noticed by former workers. GRABAU (1931), for instance, described the presence of " quaternary " septa in his *Waagenophyllum mongoliense*. His " quaternary " septa are actually tertiary septa in common usage, as before stated. But what he considered " Quaternary " septa appears to be merely interspaces in a thick stereowall. The question was fully discussed in detail in the former chapter on *Waagenophyllum*.

In " *Waagenophyllum* " *magnificum* true tertiary septa are to be discernible, although DOUGLAS confused long minor septa with major ones.

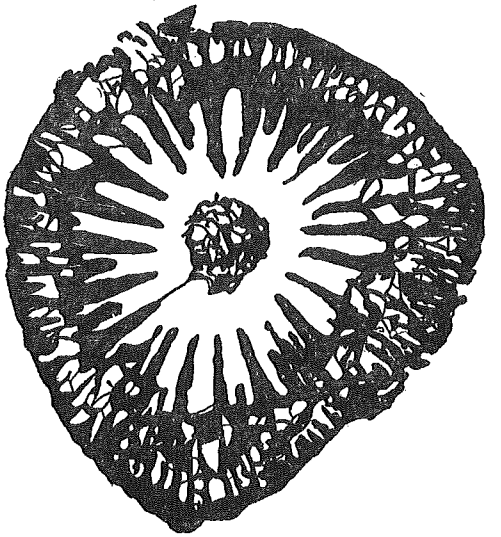
We regard it desirable to separate these fasciculate corals with three or more order of septa from the true *Waagenophyllum*. And further we think that the new

genus probably gave rise to *Wentzelella* along its way of becoming cerioid by compaction.

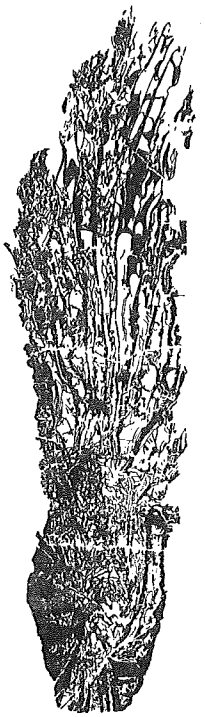
Praewentzelella magnifica (DOUGLAS)

1936 *Waagenophyllum magnificum* DOUGLAS, p. 23, pl. 2, figs. 6, 6 a.
? 1938 *Waagenophyllum* cfr. *magnificum*, CHI, p. 179, pl. 2, figs. 5 a–b.
Holotype: Slide no. 318, Specimen G.S.I. 15904.
Type locality: Tang-i-La Mir, Gahkum area, Iran.
Geological age: Judging from the associated occurrence of *Polythecalis* spp., the horizon of the present form may correspond to Chinese Chihsian, which is *Pseudofusulina* to *Parafusulina* zone.

Remarks: CHI described a Chinese coral from Yunnan as *Waagenophyllum* cfr. *magnificum*. However it is doubtful that this Chinese form has distinct tertiary septa. He did not mention about this feature, and his illustration was so inadequate that we are unable to confirm the resemblance of Chinese form with Iranian type, except for the unusually large size of Chinese form as a *Waagenophyllum*.



Text-figure 55
Praewentzelella honjoi MINATO et KATO, sp. nov. (×6); Akasaka, Gifu Prefecture. *Neoschwagerina* zone. UHR 18204.



Text-figure 56
Praewentzelella honjoi MINATO et KATO, sp. nov. (×3.3); Akasaka, Gifu Prefecture. *Neoschwagerina* zone. UHR 18203.

Praewentzelella honjoi sp. nov.

Pl. 4, figs. 3–4; Pl. 16, figs. 1–5;
Text-figs. 55, 56.

Holotype: U.H. R. 18204 Coll. by Dr. S. HONJO.
Paratype: U.H.R. 18196–18203.
Type locality: Akasaka limestone, Gifu Prefecture, Japan.

Description: Corallum may be fasciculate, although coralites were found to be fairly widely separated from each other. Corallite fairly large, ranging from 9 to 11 mm in diameter in mature stage. Major septa are as many as 20 to 22 in number. Minor septa alternating with major, attain about one half to two thirds of the length of the latter. Minor septa present, but short. Septa are diffuso-trabecular or fibro-normal type under microscope, and thick in tabularium and at the periphery, while they are thin in dissepimentarium. Triareal arrangement of internal structure is very clear. Dissepimentarium is comparatively narrow, consists of two or three rows of dissepiments. Tabularium broad, in which

intrathecal dilation occurs as above stated. Axial column is round in outline, rather small, occupies about one third to one fifth to the diameter of corallite. Axial column is somewhat irregularly constructed by axial tabellae and few, short septal lemellae. Median plate is not clearly recgonizable. Epitheca thick.

In longitudinal section, triareal arrangement is also clearly seen. Dissepiments are small, but in irregular forms, occupy a narrow area. Clinotabulae are large, and dominant in tabularium where almost no horizontal tabulae are seen. Axial column is straight, clearly differentiated from the tabularium, consists of gently uparched axial tabellae and short, discontinuous septal lamellae.

Remarks: No comparable forms to the present new species are known. Although it belongs to the same genus the present form differs considerably from *P. magnificum*. *Magnificum* provides thinner, and longer septa and larger corallite in comparison to the present form. They certainly belong to a different stock from each other, although they share the common point, in that both have fasciculate corallum and tertiary septa. As to the fasciculate nature of *P. honjoi*, however, there lies some doubt about it. Because the coral was found in fragmentary state, it is rather dangerous to say decisively that this belongs to fasciculate form. But even if this species is to become a non-fasciculate form, and is transferred to *Iranophyllum* to which it may belong, there is no comparable form with the present one.

Geological horizon: *Neoschwagerina* zone.

Praewentzelella multiseptata (ENDERLE)

1901 *Lonsdaleia multiseptata* ENDERLE, p. 95, pl. 8, figs. 12a–b.

Lectotype: ENDERLE had two specimens but he did not give any information on the type of this coral. We designed a specimen figured in fig. 12 of his plate 8 as a lectotype.

Type locality: Tsinarli Tsesme and Demirdji Alan, Asia Minor.

Geological age: Permian.

Remarks: The coral seems to be a transitional form between cerioid and fasciculate forms. But unfortunately the species can not be throughly understood as to its characters. Large size of corallites and numerous septa of the present form may characterize the species. The present form possesses fairly long tertiary septa with certainty, which are regularly alternating with quaternary septa in the full grown stage.

(III. Massive forms)

Genus *Wentzelella* GRABAU, 1932

1915 *Waagenella*, YABE and HAYASAKA (partim), p. 96 (34).
1931 *Wentzelella* GRABAU in CHI (nom. nud), p. 34.
1932 *Wentzelella* GRABAU in HUANG, pp. 44, 46, 58.
Non *Wentzelella*, DOBROLYUBOVA, 1936, p. 145.
1941 *Wentzelella*, SMITH, p. 9.
Non *Wentzelella*, SOSHKINA, DOBROLYUBOVA and PORFIRIEV, 1941, p. 262.
1950 *Waagenophyllum* (*Wentzelella*), WANG, p. 213.
1953 *Wentzelella*, FOMITCHEV, p. 48.
1955 *Wentzelella*, WANG, YÜ and YOH, p. 43.
1956 *Wentzelella*, LEED, p. 17.
1956 *Wentzelella*, HILL, F. 309.
1958 *Wentzelella*, HUDSON, p. 185.
1962 *Wentzelella*, SOSHKINA & DOBROLYUBOVA, p. 343 (partim).
1963 *Wentzelella*, YÜ, LIN & FAN, p. 25.
1963 *Wentzelella*, WU, p. 494, 500.
Type species: *Lonsdaleia salinaria* WAAGEN et WENTZEL, 1886.

Generic diagnosis: Cerioid Waagenophyllidae with tertiary septa, and rarely with quaternary septa. Wall essentially thin but strengthened in general by denticulate septal ends to form so-called septal walls. Axial column prominent. Tabulae are either horizontal or steeply inclined. Elongate dissepiments variously developed. Lonsdaleoid dissepiments are originally lacking, especially in the primitive forms, but they develop to a certain degree in more advanced forms.
Geologic distribution: *Pseudoschwagerina* to *Yabeina* zone.
Geographical distribution: Russian Far East, N. China, Japan, S. China, Indochina, Caracorum, Pakistan, Iran and Asia Minor.
Remarks: *Wentzelella* is the oldest genus which has ever been proposed as a branch of *Waagenophyllum*. It was 1931 when this name first appeared in scientific literature. Since then, this genus has been variously interpreted by many palaeontologists. In 1958 HUDSON, however proposed to regard *Wentzelella* by restricting the forms with three or more orders of septa. He included *Lonsdaleia canalifera* (MANSUY), and *Lonsdaleia socialis* MANSUY into *Wentzelella*, besides the type species, *Lonsdaleia salinaria* WAAGEN et WENTZEL. At the same time HUDSON established a genus *Ipciphyllum*, into which many species of *Wentzelella* in older usage such as *Wentzelella subtimorica* HUANG, *Wentzelella elegans* HUANG etc. were newly placed; all of them have first and second orders of septa only,

instead of having higher orders of septa. In 1961 FONTAINE denied the validity of genus *Ipciphyllum* but distinguished such forms with canals as *Lonsdaleia socialis* and *canalifera* under the distinct generic name of *Parawentzelella* from *Wentzelella* defined by HUDSON. Now, we are of the opinion that the genus *Ipciphyllum* is valid, further *Parawentzelella* can be also regarded to form another valid genus, but it may more nearly akin to *Ipciphyllum* than the proper *Wentzelella* defined by HUDSON, based on reasons which will be given later. As a result, *Wentzelella* now includes a rather limited number of spcies. Now, two types among *Wentzelella* are distinguishable in a restricted sense: one is represented by such species whose minor septa are definitely shorter than the major ones, while the other is characterized by such species in which minor septa are hardly distinguishable from the major ones except for their relative thinness.

Also, *Wentzelella* is divisible into two major groups in regard to the width of tabularium in which sub-horizontal tabulae occupy. Further *Wentzelella* can be also divided into a few groups by the different orders and number of septa, as LEED (1956) once proposed.

In compilation of phylogeny of *Wentzelella*, we brought all such criteria stated above together, because they all seem to be quite adequate to classify the corals of this group.

In addition, certain species group which have always quaternary septa and fairly well developed lonsdaleoid dissepiments are now concluded to be separable from *Wentzelella* proper in the subgeneric rank, and such species, we believe, would be best called *Wentzelella* (*Szechuanophyllum*), since we were lately informed by WU 1963 that the generic name *Szechuanophyllum* was already proposed by WANG 1957 for the corals now in question.

Thus, two subgenera can be distinguished in the genus *Wentzelella*: *Wentzelella* (*Wentzelella*) and *W.* (*Schzeuanophyllum*). *Wentzelella* is a very important coral indicating the extension of the Permian Tethys sea as in the case of *Waagenophyllum*. In this respect, the Arctic forms of so-called *Wentzelella* await a more detailed investigation. For instance, GORSKY (1938) once described three species of *Wentzelella* from the Carboniferous of Novaya Zemlya, but they actually represent cerioid from of *Corwenia* in our opinion. A new generic name may be needed for them and it is naturally quite distinct from *Wentzelella*.

Subgenus ***Wentzelella*** GRABAU, 1932

Type species: Same as for the genus *Wentzelella*.

Diagnosis: *Wentzelella* without lonsdaleoid dissepiments, or with quite incipient ones, if any. Quaternary septa are not always lacking but are relatively less deve-

loped if they are present.

A key to species of *Wentzelella* (*Wentzelella*)

1) Tabularium occupied by horizontal or sub-horizontal transverse tabulae is narrow.
   1a) with longer minor septa but without quaternary septa; septa are generally thin.
      corallites larger ..... *salinaria*
      corallites smaller, with narrow gaps ..... *salinaria* var.
      axial column small..... *simplex*
   1b) With longer minor septa and quaternary septa; septa are generally thick, without gaps or " canals " ..... *wynnei*
2) Tabularium with horizontal or sub-horizontal tabulae is wide and with shorter minor septa.
   2a) Without quaternary septa
      showing no lonsdaleiastraeimorph trend..... *regularis*
   2b) With quaternary septa ..... *osobudaniensis*

Geologic range: *Pseudoschwagerina* to *Yabeina* zone.

Geographical distribution: Iran, Salt range, Indo-china, N. China, Tibet and Japan.

Wentzelella* (*Wentzelella*) *salinaria (WAAGEN et WENZTEL)

1886 *Lonsdaleia salinaria* WAAGEN and WENTZEL, p. 895, pl. 100, figs. 1, 3, 4, 1914 (non *Lonsdaleia salinaria*, MANSUY).

1930 *Lonsdaleia* (*Waagenophyllum*) *salinaria*, REED, p. 4, pl. 4, figs. 5.

Type has not been designated so far. WAAGEN and WENTZEL's specimens may not be traceable any more. They established this species on six specimens from the Salt range.

Localities: Virgal, Vurcha, Musakheyl, Omarkheyl of Trans Indus, Rotta Roh and Punjab, all in Pakistan.

Geological horizon: Middle Productus limestone of Salt range. The age of which may be correlatable to the *Neoschwagerina* zone in rough estimation, although the lower limit of the limestone may represent a little lower horizon than the *Neoschwagerina* zone.

Remarks: This species is characterized by its comparatively thin wall and long minor septa which are almost the same length as the major ones: both of which nearly reach the axial column.

REED described the species from Tibet, which was reported to have been collected together with species of " *Schwagerina* " *princeps*. Hence the age of this Tibetian specimen must be Sakmarian (= *Pseudoschwagerina* zone). REED did not give the dimensions of the Tibetian form, however it appears to be a small

variety of *Wentzelella salinaria* judging from his illustration.

MANSUY's form from Indochina is not conspecific with specimens from Pakistan, and has thick walls. FONTAINE (1961) restudied MANSUY's material, and concluded that it belongs to a new form, to which he gave the specific name of *regularis*.

SEN (1931) described "*Lonsdaleia canalifera*" from Salt Range. But the species was unfortunately not identical with the said species but similar to *Wentzelella salinaria* or *wynnei*. This form, judging from his illustration, has a very compact axial column, thick walls and fairly long tertiary septa. The so-called canals of this form was the interruption of continuation of the wall, thus it shows lonsdaleiastraeimorph trend.

A specimen (B.M.R. 34664) in the PINFOLD collection kept at the British Museum of Natural History closely resembles the above mentioned specimen of SEN, according to the junior author's observation. This specimen was said to have been collected two miles south of Kundal, Mianwadi District Punjap, Pakistan (32° 33′N, 71° 31′E). (See also description on *Wentzelellites senni*).

This nature of partial vanishing of walls in the above spcimens clearly indicates a morphological tendency (thamnasterioid or lonsdaleiastraeimorph tendency) from *Wentzelella* to *Lonsdaleiastraea*.

Further, it may be necessary to note that this transitional form between *Wentzelella* and *Lonsdaleiastraea*, has a compact axial column, besides a partial suppression of walls.

Finally the dissepimentarium of the species now in consideration must also be examined in detail. According to the illustrated figure given by WAAGEN and WENTZEL, large elongate dissepiments and steeply inclined clinotabulae are well developed in this species. In spite of it, a fairly wide space is still occupied by globose dissepiments. In this respect such cerioid forms of Waagenophyllidae as the present species certainly shows a rather primitive nature than fasciculate forms of Waagenophyllidae, e.g., *Waagenophyllum indicum* as well as *virgalense;* although all of them are found in the same beds in the Salt Range.

Wentzelella* (*Wentzelella*) *salinaria (WAAGEN et WENTZEL) var.

1930 *Lonsdaleia* (*Waagenophyllum*) *salinaria*, REED, p. 4, pl. 4, figs. 5, (non WAAGEN and WENTZEL, 1886).

Type locality: Black compact limestone at Shendza Dzong (Loc. No. K. 21. 523 of REED), Tibet (Lat 30° 56′ N long 88° 38′).

Remarks: A single cross section of a piece of corallum was figured by REED, but the characteristics of longitudinal section is unknown.

It appears however to be not so much different from the type species of

Wentzelella (*Wentzelella*), except for the smaller size of corallites. Nevertheless we think that this form would be better dealt with as a distinct varietal form from WAAGEN and WENTZEL's species, through its different geological horizon. In future when this Tibet form is studied more in detail, based on more perfect material, the more primitive nature regarding to dissepiments and tabulae of this form may be elucidated. In any event, this Tibet specimen may be quite important in the consideration of the ancestral form of *Wentzelella*.

Wentzelella* (*Wentzelella*) *wynnei (WAAGEN et WENTZEL)

1886 *Lonsdaleia wynnei* WAAGEN and WENTZEL, p. 896, pl. 99, figs. 2a–b, pl. 100, figs. 5, 6.
Syntype: Two specimens from Katta.
Geological horizon: Middle Productus limestone.

Remarks: The species differs from *Wentzelella* (*Wentzelella*) *salinaria* (WAAGEN et WENTZEL) in having slightly larger corallites and thicker walls. Tertiary septa are better developed than *salinaria;* further, quaternary septa locally begin to develop. Both species are however closely related in that they have longer minor septa and very narrow horizontal tabulae.

***Wentzelella* (*Wentzelella*)** sp.

In a previous paper, the senior author (1955) mentioned the occurrence of *Wentzelella* (*Szechuanophyllum*) *kitakamiensis* near Yamamoto, Yonesatomura, Esashi-gun, Iwate Prefecture.

The specimen was collected by T. YOSHIDA there, which is only represented by an external mould impressed on calcarous slate. The age is the *Pseudoschwagerina* zone (the lower part of the Sakamoto-sawa series). It is quite certain that the specimen belongs to *Wentzelella*, since it is cerioid in form and has tertiary septa.

The senior author then assigned this coral into *W.* (*S.*) *kitakamiensis* merely based on the similar size of corallites and similar sized calicular boss at a rather deep calyx. In the course of the present study, we became however aware of this form to be rather near to *Wentzelella salinaria* than *kitakamiensis* especially since its varietal form was found from the Lower Permian of Tibet.

The specimen in question has a thin wall not strenghened by any thick septal denticles, and does not possess quaternary septa or lonsdaleoid dissepiments.

The material is unfortunately very imperfectly preserved, which prevents a detailed study, yet it is quite important through its oldest respresentative of the

genus *Wentzelella* as in the case of the Tibetian coral reviewed in the foregoing pages.

Wentzelelella* (*Wentzelella*) *regularis FONTAINE

Text-fig. 6a.

1914 *Lonsdaleia salinaria*, MANSUY (non WAAGEN & WENTZEL, 1886), p. 12, pl. 1, figs. 9a–b & 10a–b; pl. 5, fig. 4.
1961 *Wentzelella szechuanensis* vaf. *regularis* FONTAINE, p. 178, pl. 22, figs. 1–3; pl. 24, fig. 6; pl. 25, figs. 5–6.
Holotype: GUBLER collection No. S/G 29.
Type locality: Phnom Takream, Cambodge.
Geological age: " Kazanian " by FONTAINE—" *Yabeina-Lepidolina* " zone.

Diagnosis: *Wentzelella* with wide transverse tabulae, but without quaternary septa and less developed lonsdaleoid dissepiments.
Remarks: Although FONTAINE regarded this form to be a mere variety of *Wentzelella* (*Szechuano.*) *szechuanensis*, it has no similarity with the Chinese species. In actuality, there is a closer resemblance to *Wentzelella* (*W.*) *osobudaniensis* IGO.

The present form is quite characteristic in having shorter minor septa and teriary ones. Further, septa are in general very thin besides the axial column being small and not complex. Lonsdaleoid dissepiments may develop poorly. Horizontal tabulae are wide. Certain elongate dissepiments also develop, and are located in a relatively narrow space of inner dissepimentarium.

According to FONTAINE, this species indicates the highest fusulinid zone, instead of its rather primitive nature in morphology regarding septa, wall and also smaller sized axial column. Yet this species is remarkable in its comparatively larger corallites. Possibly, this species is not far differentiated from its ancestral form. The mentioned ancestral form, though not actually known at the present moment, if we do found it in the future, it will certainly have smaller axial column. Thus, the hypothetical ancestral form may not show any significant difference from the species now in question.

Wentzelella* (*Wentzelella*) *osobudaniensis IGO

Pl. 18, fig. 2; Text-fig. 6b.

1959 *Wentzelella osobudaniensis* IGO, p. 83, pl. 8, figs. 3.
1960 *Wentzelella nabaensis* YAMAGIWA, p. 73, pl. 1, figs. 1a–b.
Holotype: Reg. No. 20472, Department of Geology and Mineralogy, Faculty of Science, Tokyo University of Education.

Type locality: Osobudani, Fukuji, Kamitakara-mura, Yoshiki-gun, Gifu Prefecture.
Geological age: Holotype of this species was found in a pebble of Sorayama conglomerate, which we consider to be the *Parafusulina* zone. Therefore the age of the present coral may represent the *Pseudofusulina* horizon.

Remarks: IGO did not show any figures of the longitudinal section, but his species resembles *Wentzelella* (*Szechuano.*) *szechuanensis* to some extent in the transverse section. The former has shorter major and tertiary septa and slightly smaller corallites than the latter. Also the axial column of the former is not as compact as that in the latter. Therefore the present form is specifically distinct from *W.* (*S.*) *szechuanensis* with certainty.

Meanwhile, YAMAGIWA once proposed a new species based on the material from the Permian at Nabae, Takahama City, Fukui Prefecture, Japan. The specimen was reported to have been found in a conglomeratic pebble of the Maizuru group there. The age of the coral is accordingly not known. YAMAGIWA's specimen, however, shows in close resemblance to IGO's material, except for its slightly larger axial column and larger corallites.

The difference is not really however so great as to specifically separate the two forms. Both of them are nearly akin to *Wentzelella* (*W.*) *regularis* FONTAINE especially in its poor development of lonsdaleoid dissepiments and shorter septa, and in its possessing a wide horizontal transverse tabulae. Nevertheless the present form is also distinct from *regularis* in having quaternary septa, though they are only incipient in development.

Wentzelella* (*Wentzelella*) *simplex YÜ et LIN.

1962 *Wentzelella szechuanensis* var. *simplex* YÜ and LIN, p. 26, pl. 4, figs. 1a–b.
Holotype: C 419, Changchun Geological College, Kirin, China.
Type Locality: Kalachiehko-shan, South of Uch Turfan (Wushih), Sinkiang, China.
Horizon: Lower Permian.

Remarks: Unfortunately, the species is rather poorly illustrated. According to the description of the species given by YÜ and LIN, the species has 20 major septa in a corallite of 9 mm diameter. Minor septa are very long, being 4/5 the length of the major. Tertiary septa are present, but quaternary ones are lacking. Axial column is elliptical or round in cross section, and is thickened on its outer surface, with a diameter of 1.5 to 1.8 mm. Lonsdaleoid dissepiments are only feebly detectable. Tabularium is rather narrow.

From the characters above described the present species is apt to be classed under *Wentzelella* (*Wentzelella*), instead of being an ally to *Wentzelella* (*Szechuanophyllum*) *szechuanensis*.

The species is distinguishable from the other species of *Wentzelella* (*Wentzelella*) in having narrow tabularium, no quaternary septa and a small axial column.

Subgenus ***Szechuanophyllum*** WANG, 1957

1957 *Szechuanophyllum* WANG (fide WU, 1963, pp. 494,500).
Type species: *Wentzelella szechuanensis* HUANG, 1932.

Diagnosis: *Wentzelella* with quaternary septa and fairly well developed lonsdaleoid dissepiments.
Included species:

Wentzelella (*Szechuanophyllum*) *kitakamiensis* YABE et MINATO, 1944.
W. (*S.*) *szechuanensis* HUANG, 1932.
W. (*S.*) *szechuanensis* var. of FOMITCHEV, 1943.
W. (*S.*) *caracorumensis* GERTH, 1938.

Remarks: Of the four species above enumerated, the first species has a relatively narrow tabularium in which horizontal or sub-horizontal tabulae are distributed, while the other species possess a rather broader tabularium.

Geologic distribution: *Pseudofusulina* to *Yabeina*? zone.
Geographic distribution: Russian coastal region, N. China (Manchuria), Japan, S. China and Caracorum.

Wentzelella (***Szechuanophyllum***) ***kitakamiensis*** YABE et MINATO

Pl. 1, fig. 5; Pl. 17, figs. 1–2;
Text-figs. 6c, 6d & 7a.

1944 *Wentzelella kitakamiensis* YABE and MINATO, p. 139, pl. 71.
1955 *Wentzelella kitakamiensis*, MINATO, p. 111, pl. 25, figs. 6, text-figs. 8E, 1, 2, 3.
1956 *Wentzelella subtimorica*, NODA, pl. 6, figs. 1, (non *Wentzelella subtimorica* HUANG 1932).
Syntype: U.H.R. (slides) 15157, 15158, 15163, 15235. Department of Geolgoy and Mineralogy, Faculty of Science, Hokkaido Univ., Sapporo, Japan.
Type locality: Kattizawa, Sumita-cho, Kesen-gun, Iwate Pref., Japan.
Geological horizon: *Neoschwagerina* zone (see chapter on stratigraphy).

Remarks: This species closely resembles *Wentzelella* (*S.*) *szechuanensis* HUANG and is sometimes hardly distinguishable from each other, when only the respective resembled corallites in cross section are compared.

However the present form specifically differs from the latter with certainty in that it possesses more narrower horizontal transverse tabulae, thicker septa in

general, and longer minor septa. Further, lonsdaleloid dissepiments may appear in the cross section being generally small and round in *szechuanensis*, but they are fairly large and transversely elongated encircling the outer walls in the present form.

U.H.R. specimens 15161, 1562 and 15164 from east of Abu pass, Matsukawa-mura, which were considered by the senior author to be referable to the present species, seem to be slightly deviated from the holotype in having smaller corallites (8–10 mm in diameters), smaller axial column and shorter minor septa. They may accordingly more closely resemble *Wentzelella szechuanensis* than the present form. Also, the specimen presented by NODA from Toman formation of S. E. Manchuria seems to resemble the Abu-specimens because of its smaller axial column.

However, in regard to the length of minor septa considerable variation is also observable both in the Abu and Toman specimens and the some of the minor septa show the same length of the major ones as in the case of the holotype of *kitakamiensis*, but in other corallites they are comparatively short; it cannot be cosidered as adequate criterion and a specific distinction.

Abu and Toman specimens certainly possess narrow axial column like *Wentzelella szechuanensis*, but both are quite close to the holotype of *kitakamiensis* in other morphological features, especially in their thicker septa as a whole. Hence we regard these two specimens (Abu and Toman) to be also assignable into *kitakamiensis* as the senior author suggested.

NODA's specimen of the Toman formation is said to have been collected at Tsaihsiuling, S. E. Manchuria, the boundary region between Korea, China and Soviet Russia. This was found from the Lower part of the Toman formation, in association with *Schwagerina* species.

From the Toman formation, *Yabeina* and *Lepidolina* are abundantly known to occur, besides many other fossils indicating a possibility of correlation to the Middle Productus limestone in Salt Range (See MINATO 1943 and NODA 1956).

Although the exact stratigraphical position of this coral of Toman formation is unknown in field, the age may be that of the *Neoschwagerina* zone with a high posibility.

Wentzelella* (*Szechuanophyllum*) *caracorumensis GERTH

1938 *Wentzelella caracorumensis* GERTH, p. 232, pl. 15, fig. 1.
Syntype: M. 50, M. 55 DE TERRA collection.
Locality: Kyam, East Caracorum.
Geological age: Permian.

Remarks: The species is characterized by a small axial column and slight develop-

ment of lonsdaleoid dissepiments and thick denticulate wall which is in part discontinuous.

Wentzelella (*Szechuanophyllum*) *szechuanensis* HUANG

1932 *Wentzelella szechuanensis* HUANG, p. 62, pl. 5, fig. 4.
Non *Wentzelella* aff. *szechuanensis*, DOUGLAS; non FOMITCHEV, 1953.
Holotype: Cat. No. 3869 Geological Survey of China.
Geological horizon: " *Tetrapora* " zone of Chihsia limestone.

Remarks: This species is closely akin to *Wentzelella* (*S.*) *wynnei* (WAAGEN et WENTZEL) but differs from the latter in its narrow axial column, short minor septa, wide horizontal tabulae and the presence of lonsdaleoid dissepiment. The reverse is the condition seen in *Wentzelella* (*W.*) *wynnei*.

The present form is more nearly allied to *Wentzelella* (*S.*) *kitakamiensis* in having fairly well developed quaternary septa and lonsdaleoid dissepiments, but is specifically distinct from the latter in many points described in the preceding species.

Wentzelella (*Szechuanophyllum*) *szechuanensis* HUANG var.

1953 *Wentzelella szechuanensis*, FOMITCHEV, pl. 49, pl. 4, fig. 6; pl. 7, fig. 3.
Compare with *Wentzelella szechuanensis* HUANG, 1932.

Remarks: A cerioid coral from Far East Russia described under the name of *Wentzelella* (*S.*) *szechuanensis* appears to resemble the Toman and Abu specimens of *Wentzelella* (*S.*) *kitakamiensis*, especially in having narrow axial column and a lesser number of septa, besides having a shorter minor septa.

However, in the Russian form, the septa are in general thin, lonsdaleoid dissepiments are small and sub-round in cross section, while the wall is highly denticulated with septa.

Thus, there is little doubt to the closeness between the Russian and the mentioned Chinese form. Further, the axial column of Russian form is as narrow as that of *W.* (*S.*) *szechuanensis*. The single objection preventing the identification between the Russian and the Chinese form lies in the relatively less numerous septa than in the latter. Hence we wish to regard the present coral as a variety of the Chinese species.

(On " *Wentzelella* " *sekii* MINATO)

1955 *Wentzelella sekii* MINATO, p. 108, pl. 26, fig. 9; Text-figs. 8D-1, 2, 3, 4.
Holotype: SEKI collection No. 108, Institute of Geology and Palaeontology, Tohoku University, Sendai: Japan.

Type locality: Oishizawa, Iwate-mura, Fuwa-gun, Gifu Prefecture.
Geological age: The age of this coral was considered by MINATO (1955) to be the *Parafusulina* zone. However, it is somewhat doubtful that this coral really represents the Permian age. According to geological maps of Ominagahama and Ohgaki by ISOMI (1955, 1956) the Otaki formation and Oishi formation develops in the vicinity of Oishizawa, the type locality. Otaki formation was thought to belong to middle Carboniferous, but a later discovery of schwagerinids from this formation suggests its age similarity to the Oishi formation, which is the lower Permian *Pseudofusulina* zone judging from fusulinids.

Many Carboniferous fossils have been collected from the Otaki formation so far, but they should now be regarded as derived fossils. And it is quite probable that the so-called *Wentzelella sekii* is also a derived fossil, because of its affinity to Carboniferous forms rather than to Permian *Wentzelella*. *Wentzelella sekii* has trabecular septa instead of being fibro-lamellar as in common waagenophyllids. It has a certain resemblance to middle Carboniferous pseudopavonids from localities in southwest Japan. Indeed " *Clisaxophyllum* " *awa*, one of these derived fossils from Otaki, strongly indicates its belonging to the middle Carboniferous fauna of the said region. Similar forms have been collected by the junior author from the Carboniferous and Permian of the Omi limestone. The latter of which is a derived fossil.

In any event this species may not be included in proper Permian *Wentzelella*, and is possibly a member of an entirely different stock, such as *Taisyakuphyllum* and *Pseudopavona*. Hence the real age may possibly be middle Carboniferous.
Remarks: Although longitudinal characters are not known in this species, the axial column is dense and irregular in shape, and is not the type of waagenophyllids. The difference in the septal construction is as already mentioned above. The presence of tertiary septa in the present form suggests its affinity to *Taisyakuphyllum* MINATO. The former may be a representative of cerioid forms of the latter.

Genus ***Lonsdaleiastraea*** GERTH, 1921

1921 *Lonsdaleiastraea* GERTH, p. 77.
1955 *Lonsdaleiastraea*, HILL, F 310.

1962 *Lonsdaleiastraea*, SOSHKINA & DOBROLYUBOVA, p. 344 (partim).
Non *Lonsdaleiastreaa*, DOBROLYUBOVA, 1936, p. 56.
Non *Lonsdaleiastraea*, FOMITCHEV, 1953, p. 499.
Type species (by monotype): *Lonsdaleiastraea vinassai* GERTH, 1921.

Generic diagnosis: Thamnastraeoid Waagenophyllidae provided with tertiary septa. The axial structure is comparatively dense in its construction.

Geologic distribution: Middle Permian (possibly from *Parafusulina* to *Neoschwagerina* zone.)
Geographic distribution: Japan, Timor and Karakorum?

Included species: *Lonsdaleiastraea vinassai* GERTH, 1921
L. molengraaffi (GERTH), 1921
L. typica GERTH, 1931
L. yamanbaensis MINATO, 1949

Remarks: GERTH originally defined his genus of *Lonsdaleiastraea* as having plocoid coralla which are otherwise like *Wentzelella* (then *Lonsdaleia*). However, we wish to restrict the genus in having tertiary septa as well as thamnastraeoid corallum.

The genus may be partly aphroid as in the type species, thus approaching towards *Polythecalis*. LANG, SMITH and THOMAS, and WANG actually thought that *Lonsdaleiastraea* is synonymous with *Polythecalis*.

However *Polythecalis* was certainly derived from *Wentzelophyllum* by losing proper wall structure, while *Lonsdaleiastraea* here defined might have arisen from *Wentzelella*, although the course of which might be polyphyletic to a certain extent.

There are some other forms once included in the genus *Lonsdaleiastraea* but which are excluded here. None of them has tertiary septa, and many of them are entirely unrelated to Waagenophyllidae.

DOBROLYUBOVA (1936) described the following " *Lonsdaleiastraea* " from Permian of Ural Mountains.

Lonsdaleiastraea cf. vinassai GERTH
Lonsdaleiastraea vinassai GERTH
Lonsdaleiastraea complexa DOBROLYUBOVA
Lonsdaleiastraea longisetata DOBROLYUBOVA

They all have arched tabulae and are rather related to *Protolonsdaleiastraea* than to waagenophyllids in general.

Further DOBROLYUBOVA in SOSHKINA et al. (1941) described several *Lonsdaleiastraea* as listed below.

Lonsdaleiastraea gerthi DOBROLYUBOVA
Lonsdaleiastraea gerthi juresanensis DOBROLYUBOVA

Lonsdaleiastraea delicata DOBROLYUBOVA
Lonsdaleiastraea complexa DOBROLYUBOVA
Lonsdaleiastraea cargalensis DOBROLYUBOVA
Lonsdaleiastraea densireticulata DOBROLYUBOVA

But they are again in the same category with those mentioned before.

FOMITCHEV (1953) also described some other *Lonsdaleiastraea* from the middle and upper Carboniferous of the Donezt basin.

They are as follows:

Lonsdaleiastraea? kumpani FOMITCHEV
Lonsdaleiastraea freislebeni (STUCKENBERG)
Lonsdaleiastraea cystiseptata FOMITCHEV
Lonsdaleiastraea sp.

Judging from illustrations given by FOMITCHEV, these Donetz forms do not possess tertiary septa, and are definitely related to Carboniferous "*Cystophora*", or *Ivonovia*, and are thus excluded from proper Waagenophyllidae.

FOMITCHEV in the same volume (1933) proposed the new generic name of *Gorskyia* for those corals described by DOBROLYUBOVA as belonging to "*Protolonsdaleiastraea*" and "*Lonsdaleiastraea*". But since he did not designate the type species of *Gorskyia*, although a short diagnostic description was given, the generic name is not available, and should be regarded as a mere nomen nudum, as HILL once remarked (1957).

Lonsdaleiastraea nipponica MINATO is also excluded from waagenophyllids, because of its having trabecular septa and arched tabulae. The age of this coral is Middle Carboniferous, and may be in the same group with "*Corwenia*" *omiensis* YABE et HAYASAKA.

Some Permian corals are very similar to true *Lonsdaleiastraea*, yet they have no diffnite tertiary septa, hence they may be classified in a different group, for which we proposed *Maoriphyllum*, a new subgenus of *Yokoyamaella*. (see remarks on *Yokoyamaella* (*Maoriphyllum*).

YAMAGIWA recently described the following two "*Lonsdaleiastraea*" from the Atetsu limestone of southwest Japan. (1962)

Lonsdaleiastraea matsushitae (sic) YAMAGIWA
Lonsdaleiastraea nishinensis YAMAGIWA

According to the descriptions for those species given by YAMAGIWA, they have no tertiary or higher orders of septa in corallites. Therefore they should be removed from the genus to which they were first assigned, and they may be better transferred to *Yokoyamaella* (*Maoriphyllum*).

There are two different groups recognizable within *Lonsdaleiastraea*. They are tabulated below in a form of Key.

I. Corallum thamnastraeoid, may be partly aphroid. Tertiary septa are well developed. Axial structure is comparatively solid.

Corallites are medium in size.....*L. yamanbaensis* group

1. Corallum completely thamnastraeoid. Axial structure is almost solid. ..... *L. yamanbaensis*
2. Corallum partly aphroid. Axial structure is solid to lamellate. ..... *L. vinassai*
3. Walls partly remain. Axial structure is columnar. .....*L.molengraaffi*

II. Corallum thamnastraeoid. Tertiary septa may be partially developed.

Corallites are small. .....*L. typica.*

Lonsdaleiastraea vinassai GERTH

1921 *Lonsdaleiastraea vinassai* GERTH, p. 77, pl. 145, figs. 6, 7.
Non *Lonsdaleiastraea* cf. *vinassai*, DOBROLYUBOVA 1936.
Holotype: Nr. 673, ser. III (D.S.) (This may be a locality number, from which a single specimen of this species was obtained.).
Type locality: Biwak Poetain, Amanatoen, Timor.
Geological age: Permian.

Lonsdaleiastraea molengraaffi (GERTH)

1921 *Lonsdaleia Molengraaffi* GERTH, p. 76, pl. 145, figs. 3, 4, 5.
Holotype: Nr. 229, ser. III, (D.S.).
Type locality: Noil Noenoe Sono, Landschaft Insasa, Timor.
Geological age: Permian.

Remarks: As GERTH remarked this species stands between "*Lonsdaleia*" (= *Wentzelella*) and *Lonsdaleiastraea*, in having partially suppressed walls. In this regard we think it better to transfer the present species to *Lonsdaleiastraea*.

Lonsdaleiastraea typica GERTH

1938 *Lonsdaleiastraea typica* GERTH, p. 15, fig. 7.
Syntype: M 59 and M 43 (figd.).
Type locality: East Karakorum.
Geological horizon: *Lyttonia* limestone of Karakorum. (Upper *Parafusulina* to *Neoschwagerina* zone).

Remarks: The development of tertiary septa in this species is not clearly dis-

cernible from the illustration given by GERTH. But in the description GERTH stated the presence of tertiary septa although they were said to be rather imperfect. In any event typical thamnatraeoid corallum of this species characterizes the form.

Lonsdaleiastraea yamanbaensis MINATO

1949 *Lonsdaleiastraea yamanbaensis* MINATO, p. 58, fig. 1.
1955 *Lonsdaleiastraea yamanbaensis*, MINATO, p. 135, pl. 3, fig. 5.
Syntype: U.H.R. 16459, 16528, 16529.
Type locality: Yamanba, near Sakawa-machi, Takaoka-gun, Kochi Prefecture, Japan.
Geological age: *Parafusulina* zone, Permian.

Remarks: This species has nearly complete thamnastraeoid corallum, although a trace of wall is still to be seen. The axial column is comparatively dense. Tertiary septa are present. As far as the type of corallum is concerned it resembles the preceding *Lonsdaleiastraea typica*, but is easily distinguishable from the latter in having distinct tertiary septa.

The age of this coral was first considered to be the *Yabeina* zone, and was later referred to *Parafusulina* zone with some doubt. However the species is associated with *Parafusulina* sp. and other brachiopods, which are, in the senior writer's view, denotes the *Parafusulina* zone.

Genus *Wentzelloides* YABE et MINATO, 1944

Type species: *Wentzelella* (sic) *maiyaensis* YABE et MINATO.
1944 *Wentzelloides* YABE and MINATO, p. 141.
1955 *Wentzelloides*, MINATO, p. 113.
1956 *Wentzelella* (*Wentzelloides*), HILL, F. 309.

Generic diagnosis: Plocoid Waagenophyllidae with meandroid development of corallites. Lonsdaleoid dissepiments absent. Tertiary septa present. Also quaternary septa are well developed on very thick walls. Septal walls are prominent, but are locally suppressed, showing a plocoidal nature in corallites.
Geologic distribution: *Yabeina* zone.
Geographic distribution: So far the genus has been only known from Japan.
Included species: *Wentzelloides maiyaensis* YABE et MINATO, 1944, only.
Remarks: This genus may be simply defined as thamnastraeoid *Lonsdaleiastraea* with strong development of walls. And the genus is well characterized in that it has a meandroid nature in corallites, conspicuous quaternary septa and no lonsdaleoid dissepiments. Small, simple, and nearly solid axial column and less

numerous major septa of the present genus may also be characteristic of the genus.

Wentzelloides was definitely derived from cerioid *Wentzelella*, although from the latter *Lonsdaleiastraea* might have been derived separately, and directly.

Wentzelloides maiyaensis YABE et MINATO, 1944

Pl. 1, fig. 3; Text-fig. 5c.

1944 *Wentzelloides maiyaensis* YABE et MINATO, p. 141, pl, 12, figs. 1–3.
1955 *Wentzelloides maiyaensis*, MINATO, p. 114, pl. 24, text-figs. 8A, 1, 2, 3.
Syntype: U.H.R. 15232, 15233, 15234, 15242, 15682.
Type locality: Yamazaki, Maiya-machi, Tome-gun, Miyagi Pref.
Geological horizon: *Yabeina* zone.

Remarks: The species has been known also from the corresponding horizon in Yumiorezawa, Soma district, Fukushima Prefecture. (T. SATO in M. MINATO, 1955)

Genus ***Wentzelophyllum*** HUDSON, 1958

1958 *Wentzelophyllum* HUDSON, p. 186.
1962 *Wentzellophyllum* (sic), YÜ, pp. 8–10.
Type species: *Lonsdaleia volzi* YABE et HAYASAKA, 1915.

Generic diagnosis: Ceriod Waagenophyllidae in which lonsdaleoid dissepiments are fairly well developed. Walls are various; thin to a little thick, or beading type and septal walls. Also the walls are seldom suppressed at least in most corallites. Tertiary septa develop in various degrees, which may be fairly long or short: they are represented in certain cases as mere septal ridges or short mural septa attached to the walls.

Geologic distribution: *Pseudoschwagerina* to *Parafusulina* zone.
Geographic distribution: Japan, China, Caracorum, Iran, Iraq, Turkey and Carnic Alps.

Remarks: Needless to say the present genus should be distinguished from *Stylidophyllum* in that it has well developed clinotabulae and elongate dissepiments. Further, the present genus possesses tertiary septa.

From *Wentzelella*, the present form can be easily distinguished by the different nature of walls and more well developed lonsdaleoid dissepiments, at least in most species. From *Polythecalis*, it is also separable from the cerioid form of corallites in the present genus and has different kinds of walls.

In addition, the septa in this genus grow in general from the cystose zone of

lonsdaleoid dissepiments but at least, some of them are still develop directly from the outer wall, even in the mature stage.

On the contraty, in *Polythecalis* septa seldom develop from walls at least in the full grown stage, even when walls are partly retained, but most septa are interrupted between the remaining walls and medial area.

A group of corals here tentatively placed in the genus *Wentzelophyllum* are all characteristic in having corallites strongly resembling that of the Lower Carboniferous " *Stylidophyllum* " in many important points of corallites. They are *Wentzelophyllum? gelikhanense* sp. nov., *Wentzelophyllum? jenningsi* (DOUGLAS), *Wentzelophyllum? orientale* (DOUGLAS), *Wentzelophyllum? douglasi* sp. nov., *Wentzelophyllum? langpotangense* sp. nov., *Wentzelophyllum? persicum* (DOUGLAS) and *Wentzelophyllum? tabasense* sp. nov.

In the species above enumerated tertiary septa are however mostly incipient in form or almost lacking. In spite of this, most of them provide definite clinotabulae and elongate dissepiments. At least so far as the species in which longitudinal characters are accessible by direct observation of material or through the description or illustration given by the former workers are concerned, the presence of clinotabulae and elongate dissepiment are beyond doubt.

Thus, we tentatively assign these species into the genus *Wentzelophyllum*, instead of " *Stylidophyllum* " or *Ipciphyllum*.

In reality, certain species, *W.? orientale*, *W.? jenningis* and *W.? tabasense* for example, are almost lacking in tertiary septa. Accordingly, they can be hardly distinguished from certain species belonging to the genus *Ipciphyllum* in which lonsdaleoid dissepiments are fairly well developed. Yet, in the genus *Ipciphyllum*, septa are not seldom united with the wall even in the mature stage and the lonsdaleoid dissepiments are accordingly not uniformly well developed throughout corallites like " *Stylidophyllum* " or the species group now in question. Further, the wall is always thin in *Ipciphyllum*.

In all probability, the species group now in question may be another stock from the typical *Wentzelophyllum*, both seem however, to have been certainly derived from a common ancestor of certain lonsdaleoids, Carboniferous " *Stylidophyllum* " for instance.

Perhaps, the species group which is assigned into the *Wentzelophyllum* with a slight doubt may have evolved along a course which produced clinotabulae and elongate dissepiments which is likewise the typical form of *Wentzelophyllum*. However the former might be rather conservative in producing tertiary septa. Eventually they are also progressive in the development of lonsdaleoid dissepiments.

On the contrary, *Ipciphyllum* is entirely lacking in tertiary septa, besides it seems to be rather retrogressive in development of the lonsdaleoid dissepiments. Hence the difference may be doubtless.

In addition, the columella of *Ipciphyllum* seems to be much deviated in general from the typical spider-web structure of the Carboniferous " *Stylidophyllum* ". If one compares the axial structure of *Wentzelophyllum* to that of *Stylidophyllum* and *Ipciphyllum* the difference in this regard may also be obvious.

Wentzelophyllum? persicum (DOUGLAS)
Wentzelophyllum? gelikhanense sp. nov.
Wentzelophyllum? douglasi sp. nov.
Wentzelophyllum? orientale (DOUGLAS)
Wentzelophyllum? jenningsi (DOUGLAS)
Wentzelophyllum? tabasense sp. nov.
Wentzelophyllum? langpotangense sp. nov.

Beside the above species which will be tentatively assigned into the genus *Wentzelophyllum*, the following species may be included into the present genus.

Wentzelophyllum volzi (YABE et HAYASAKA), 1915
Wentzelophyllum volzi mut. *alpha* (HUANG). 1939
Wentzelophyllum volzi mut. *beta* (HUANG), 1939
Wentzelophyllum volzi mut. *gamma* (HUANG), 1939
Wentzelophyllum chaoi (HUANG), 1932
Wentzelophyllum kueichowense (HUANG), 1932
Wentzelophyllum kueichowense var. *alpha* (DOUGLAS), 1950
Wentzelophyllum kueichowense var. *beta* (DOUGLAS), 1950
Wentzelophyllum huayunshanense TSENG, 1950
Wentzelophyllum arminiae (FELSER), 1937
Wentzelophyllum felseri sp. now.
Wentzelophyllum eguchii (YOKOYAMA), 1960
Wentzelophyllum hayasakai sp. nov.
Wentzelophyllum intermedium (HUANG), 1932
Wentzelophyllum kinkiense (SAKAGUCHI et YAMAGIWA), 1963

Wentzelophyllum volzi (YABE et HAYASAKA)

1915 *Lonsdaleia volzi* YABE and HAYASAKA, p. 108.
1920 *Lonsdaleia volzi*, YABE and HAYASAKA, pl. 8, figs. 6a, b.
1932 *Stylidophyllum volzi*, HUANG, p. 65, pl. 6, figs. 1, 2, 3 ; pl. 10, fig. 1.
Non 1939 *Stylidophyllum volzi*, HERITSCH, pl. 2, fig. 6.
Non 1937 *Stylidophyllum volzi*, FELSER, p. 13, pl. 1, figs. 8a, b.
Lectotype: The slide given by YABE and HAYASAKA on plate 8, figs. 6, a, b. is here designated as a lectotype.
Type locality: Hou-chang, Wei-ning-hsien, Prov. Kueichw.
Geological horizon: According to HUANG, (1932) this is a good horizon indicator for

the " *Stylidophyllum volzi* " zone which may be almost equivalent to our *Pseudofusulina* zone.

Remarks: HUANG reported this coral at least from four localities in Kueichow, and near Nanking; all of them are said to come from the Chihsia limestone, especially forming the lower part. This species is characteristic in having beading type of walls and a prominent median plate in the axial structure. Further, the present form does not possess any long tertiary septa, which are generally represented by short septal ridges attached to the walls, and they are by no means numerous.

HUANG distinguished three mutations among the present species, regarding the nature of the median plate and axial tabellae in the axial structure, cystose zone, or thickness of septa.

Wentzelophyllum volzi mut. ***alpha*** (HUANG)

1932 *Stylidophyllum volzi* mut. *alpha*, HUANG, pl 69, pl. 10, fig. 2.
Type specimen: Geological Survey of China, Cat. no. 3893.
Type locality: Chihsia limestone, I li west of Laochialiang, Lipohsien, Kueichow (Loc. no. T 269), Coll. V. K. TING.
Geological horizon: Same as the Preceding species.

Remarks: According to HUANG, the present mutation is distinct from the typical form of *volzi* in having no prominent median plate in the columella, but otherwise the present mutation does not differ significantly from the latter.

Wentzelophyllum volzi mut. ***beta*** (HUANG)

1939 *Stylidophyllum volzi* mut *beta*, HUANG, p. 69, pl. 5, fig. 5.
Type specimen: Geological Survey of China, cat. no. 3869.
Type locality: Chihsia limestone at pass N.W. of Langpotang, Lipohsien, Kueichow (Loc. no. T247b).
Geological horizon: Same as the preceding mutation.

Wentzelophyllum volzi mut. ***gamma*** (HUANG)

1932 *Stylidophyllum volzi* mut. *gamma*, HUANG, p. 69, pl. 10, fig. 3.
Type specimen: Geological Survey of China, Car. no. 3894.
Type locality: White limestone of Waitaoshan, Weininghsien, Kueichow (loc. no. x No. 1),

in association with the type species. Coll. V. K. TING.
Geological horizon: Same as the preceding mutation.

Wentzelophyllum chaoi (HUANG)

1932 *Stylidophyllum chaoi* HUANG, YOH and HUANG, p. 35, pl. 9, figs. 5a–b.
Non *Stylidophyllum chaoi*, HUANG, 1932, p. 73, pl. 7, fig. 3.
Holotype: Geol. Surv. China. Cat. no. 3936, illustrated by YOH and HUANG as figs. 5a, 5b on their plate 9.
Type locality: Chihsia limestone, south of Nan-kao, Chang-hsinghsien, Chekiang (Loc. no. 901). Coll. C. C. LIN and Y. T. CHAO.
Geological horizon: *Pseudofusulina* to *Parafusulina* zone.

Remarks: The present form possesses a little thicker wall than the forms which will be later described as *Wentzelophyllum*(?) spp.

Further septa sometimes develop directly from the outer walls, and crestal septa including tertiary septa are more pronounced than in most *Wentzelophyllum*.

Wentzelophyllum kueichowense (HUANG)

text-fig. 7c.

1932 *Stylidophyllum kueichowense* HUANG, p. 70, pl. 6, figs. 4, 5, 6, (7?); pl. 7, fig. 4.
Non *Stylidophyllum kueichowense*, DOUGLAS, 1936, p. 14, pl. 2, figs. 1–1a.
1950 *Stylidophyllum kueichowense*, DOUGLAS, p. 14, pl. 2, fig. 1 (non figs. 2 & 3).
Syntype: Nos. 3874–6, Geol. Surv. China.
Type locality and geological horizon: Chihsia limestone at 5 li No. of Liang-lu-koi, Tu-shan-hsien, Kueichow, in association with "*Stylidophyllum*" *volzi* (Loc. no. T. W. 25).

Remarks: The present form seems to closely resemble the typical species of *Wentzelophyllum* (*Wentzelophyllum*). Whether sclerotheca (inner wall) is distinct or indistinct in these two species cannot be regarded to be a good criterion to separate species. Yet this form may be specifically distinct from *volzi* in showing the cystose zone to be more prominent and constant than the latter.

Wentzelophyllum kueichowense var. *alpha* (DOUGLAS)

1950 *Stylidophyllum kueichowense* var. DOUGLAS, p. 14, pl. 2, fig. 2, (non fig. 1 & 3).
Specimens: A. 10C, 114.
Locality: Kuh-i-Gahkum, Iran.

Remarks: According to DOUGLAS, to present form shows nearly the same size as HUANG's species, but the tabulate zone forms only about 1/3 of the whole, and the diameter of the axial column is 2 mm or less. There are about 20 major septa and the lonsdaleoid dissepiments, instead of being more or less uniformly convex towards the centre, are very irregular in shape and size.

Wentzelophyllum kueichowense var. ***beta*** (DOUGLAS)

1950 *Stylidophyllum kueichowense* var. *beta* DOUGLAS, p. 16, pl. 2, fig. 3.
Specimen: A.I.O.C. 113, from Kuh-i-Gahkum, Iran.

Remarks: The present form seems to be much deviated from the typical form of *W.* (*W.*) *kueichowense* in having irregularly thin walls, relatively narrower tabularium and less numerous septa.

Wentzelophyllum cfr. ***kueichowense*** (HUANG)

Compare with: *Stylidophyllum kueichowense* HUANG, 1932, p. 70, pl. 6, figs. 4–7.
1950 *Stylidophyllum kueichowense*, DOUGLAS, p. 14, pl. 2, fig. 1, 1a.

Remarks: The present form came from Pavasteh, Khoya, Southwest Iran, probably from a horizon equivalent to the *Parafusulina* zone. It is more nearly allied to *W. kueichowense* than to the type species of the genus *Wentzelophyllum*. However, it may show a different nature of wall from the latter. The walls of the present form are more pronounced in denticulation. Further, the denticles as well as crestal septa are somewhat thicker in the present form.

To be sure, the present form may be accordingly specifically distinct from the Chinese species.

Wentzelophyllum huayunshanense (TSENG)

1950 *Stylidophyllum huayunshanense* TSENG, p. 36, pl. 2, figs. 3a–b.
Horizon, locality and Holotype specimen: Upper part of Chihsia limestone of Huayunshan, E. Szechuan. Loc. no. f S42–5g, 26.
Collected by T. K. HUANG and T. C. TSENG. Geol. Surv. China, Cat. no. 6996.

Specific diagnosis: Thin septal walls composed of very short mural septa. Lonsdaleoid dissepiments are large and sub-equal in size.
Remarks: In the present form, clinotabulae and elongate dissepiments are not well developed, but their presence is doubtless. Further, a certain number of

mural septa can be regarded to be the tertiary septa, when compared to the major and minor septa. Accordingly, the present species may be safely placed into the genus *Wentzelophyllum*. Among species of the mentioned genus, the present form is characteristic in having a rather large, sub-spherical lonsdaleoid dissepiments, which are almost equal in size. Further, the wall of the present species may be originally thin but is regularly decorated by short mural septa.

Wentzelophyllum arminiae (FELSER)

1937 *Stylidophyllum arminiae* FELSER, p. 14, pl. 1, figs. 9a–c.
Lectotype: Slide figured by FELSER on his plate 1 as figs. 9a–b is here designated as the lectotype of the present species. (coral no. 68) Geological Institute of the University of Graz.
Geological horizon: Uppermost *Pseudoschwagerina* or lowest *Pseudofusulina* zone.
Type locality: So-called Upper *Schwagerina* limestone in the region of Schulterkofel-Tressdorf highland. Coll.: HANS SEELMEIER.

Diagnosis: Fairly thick major septa, thin but nearly the same length of minor septa, and distinct tertiary septa. Columella unites with the counter septum even in the full grown stage.
Remarks: Although FELSER does not seem to have noticed the presence of fairly well developing tertiary septa in the present species, their presence is beyond doubt. In the writers' opinion major septa of the present species must be confined only to the septa which are very thick, and are quite distinct from other septa, so far as the illustrated figures are concerned. The thin septa, nearly always alternate with the said major septa, and since they are as long as the latter or only slightly shorter than the latter, they are accordingly the minor septa. Actually as many as 16 major septa can be counted in the largest corallite illustrated by FELSER in fig. 9a, while the minor ones number 14. Accordingly other thin and far shorter septa must be tertiary septa of which 11 or more were counted.

Further, the characteristic thick mural septa forming the outer wall is noteworthy since they are fairly long in the present species. In addition, axial column is fairly dense and complex, in which however no distinct median plate is discernible.

Wentzelophyllum felseri, sp. nov.

Pl. 1, fig. 7; pl. 2, figs. 5–6; pl. 18, fig. 3; Text-fig. 5e.

1937 *Stylidophyllum volzi*, FELSER, p. 13, pl. 1, figs. 8a, b, (non *Stylidophyllum voltzi*, YABE et HAYASAKA 1911–1916; non *Stylidophyllum volzi* HUANG, 1932).

Holotype: The specimen figured by FELSER in his figs. 8a, b on plate 1 is here as the Holotype of the present species. Coral number 67.
Type locality: Upper *Schwagerina* limestone of Zweikofel, Carnic Alps.
Horizon: *Pseudoschwagerina* zone.

Diagnosis: Thick wall formed by thick mural septa, with thin, long major septa, nearly the same length of minor septa, besides distinct tertiary septa. The axial column is rather simply constructed, with or without median plate and with less numerous irregularly developed lamellae and tabellae.
The following description is based on a specimen collected from the so-called Lower *Schwagerina* limestone, Carnic Alps, which was placed at our disposal by Dr. MALZAHN, Geol. Survey Hannover. Several thin cross sections were made from the specimens, U. H. Reg. nos. 17880–17886.
Description: Corallum composite, massive; corallites irregularly round, elliptical or polygonal in cross section.

In the neanic stage, irregularly round corallites or triangular or irregularly quadrangular corallites are common, while in the mature stage, corallites become pentagonal, hexagonal or polygonal with more numerous edges in form, although they are mostly irregularly elongated with curved edges.

In the earliest stage, so far as the observed corallites are concerned, lonsdaleoid dissepiments are lacking. Major septa are fairly long, numbering 14, while minor septa are also already present in this stage, which are very short, however. The axial structure is represented by a mere thin plate which is the direct prolongation of the counter septum. Bilateral symmetry is obvious in the arrangement of septa in the earlier neanic stage.

In the next stage, the plate like columella becomes thick, and is apparently solid in its cross section, in which neither lamellae nor tabellae are discernible with certainty. Septa gradually grow longer, and become numerous. Also lonsdaleoid dissepiments begin to develop vigorously, and the septate peripheral zone begins to narrow.

Counter septum is generally discontinuous with the axial structure in most cases, except for the earlier ontogenic stage.

In the mature stage, as many as 20 to 22 major septa are seen, while there are more than 20 fairly long minor septa. The presence of tertiary septa cannot be denied, but they are only locally developed and very few and short; their existence is only locally indicated by short crestal septa on lonsdaleoid vesicles, except for mural septa.

Lonsdaleoid dissepiments are irregular in shape and size. They construct thick zones in some corner of the corallite, giving a marked contrast to the narrow septate peripheral area.

The axial column in this stage, reaches a maximum of 2 mm × 4 mm in cross section, in which the median plate is discernible in most corallites, being somewhat

	Slide number	form	diameter of corallite in mm		major septa	minor septa	lonsdaleoid dissepiments	axial structure			counter septum
								median plate	septal lamelae	axial tabellae	
Neanic Stage	17880	triangular	3	5	14	6	none	present			uniting
	17885	quadragular round	3	5	14	4	well developed		solid		not uniting
	17882	quandrangular	4	5	16	6	fairly well developing	present	1	3	,,
	17885	elliptical	4	5.5	15	7	well developed		solid		,,
	*17880	round	4	6.0	17	16	fairly well developing		non		,,
	17885	irregular round	5	6	16	8	,,		solid		uniting
	17883	round	6	6	16	7	,,		solid		,,
Ephebic Stage	17886	round	7	9	20	17	less developing	present	4	4	not uniting
	17886	long quadranglar	7	13	21	16	fairly well developing	,,	4	5	,,
	17883	pentagonal	8	11	22	22	,,	,,	4	4	,,
	17880	quadrangular	9	9	22	14	well developed	none	6	4	,,
	**17882	irregular quadrangular	9	10	22	10	,,	present	6	4	,,
	17882	long pentagonal	9	12	21	14	,,	,,	3	3	,,
	17886	long hexagonal	9	13	22	22	,,	,,	10	5	uniting
	17886	irregular hexagonal	9	15	22	18	,,	none	7	4	not uniting
	**17885	round hexagonal	10	12	19	8	,,	present	4	3	,,
	17881	irregular pentagonal	10	16	20	14	,,	,,	3	5	,,
	17881	,,	12	15	23	17	,,	,,	3	5	,,

* corallite by peripheral increasing. ** corallites with less numerous minor septa.

curved or sinuous and not straight, besides having a few lamellae and three or four zones of tabellae. In most cases the axial column does not directly unite with the counter septum, and the cardinal septum is always slightly shorter than the other major septa.

Lastly, there are two types observable in the increase of corallites in the present species: ie., intermural increase and peripheral increase respectively.

In the former case, offsets are, of course, small in size, in which walls are as thick as that of the neighbouring protocorallites. Axial structure begins to develop from the earliest stage, as plate or solid columella, being a direct prolongation of the counter septum. While in the latter, the offsets newly arise from lonsdaleoid dissepiments, and axial structure is wanting even in the later stage, when septa become fairly numerous (e.g. major septa 17, minor septa 16!). In addition, the walls of newly arising offsets seem to be considerably thin, compared to that of the corallites with mural increase.

Further, the earliest stage of offsets by peripheral increase provide only a few septa but lack axial structure and walls.

Wentzelophyllum eguchii (YOKOYAMA)

Pl. 18, fig. 1.

1960 *Stylidophyllum eguchii* YOKOYAMA, p. 245, pl. 27, figs. 4a–b.
Holotype: Y. T. no. 5, Inst. of Geology, Hiroshima University.
Type locality: About 200 m north of Misaka primary school, Taishaku region, Hiroshima Prefecture.
Geological horizon: Grey limestone of "*Pseudoshwagerina* zone."

Diagnosis: Fairly thick walls to which septal ridges including tertiary septa are attached.

Wentzelophyllum hayasakai, sp. nov.

Pl. 19, figs. 1–3.

Holotype: U.H.R. 18281–4.
Type locality: East of Sekiya, Hikoroichi machi, Ofunato city, Iwate Prefecture.
Collector: S. YATO.
Geological horizon: Lower Permian Sakamotosawa series. In association with *Pseudofusulina* and *Yatzengia*.

Description: Corallum compound, cerioid, and partially aphroid. Holotheca is thick, smooth on its outer surface, but internally denticulated with small, laterally

coagulated denticles corresponding to three orders of septa. Corallites polygonal, four to seven sided, and small in size; the largest one being 7 mm in diameter. Average size of corallite is about 5 mm in diameter. Epitheca is also very thick, but becomes thin and is even vanishing at places. There are some gaps observable interrupting the continuation of epitheca. Epitheca is strongly denticulated in parts, while denticles are relatively few at places. Partial interruption of epitheca is shown by gaps, which leads epitheca to total vanishment. Lonsdaleoid dissepiments present, but in varied degree. As a whole they do not occupy a wide space, so that a number of major septa are seen to stretch towards the epitheca until they firmly touch it. Lonsdaleoid dissepiments are usually represented by small cysts with some septal crests on them. Septa are in three order. Major septa may be as many as 21, but the average septal number in the present form is about 15. Major septa long, stretching towards center, but not quite touching the axial column, leaving a narrow space around it. However, one of the major septa is connected with an axial column in young corallites. Minor septa are rather short, of about one-half the length of major septa in tabularium. Tertiary septa are not well developed in tabularium, but are represented mostly by septal crests on lonsdaleoid dissepiments and denticles on epitheca. But sometimes they can be recognized to develop within tabularium. Tabularium is round in cross section, not well differentiated from dissepimentarium, and is about 2.5 mm in diameter. Axial column is relatively small, elliptical in outline, and consists of a short median plate, axial tabellae and a few septal lamellae. Shorter diameter of axial column measures 0.5 to 0.7 mm in mature corallites. In younger corallites the axial structure is merely represented by a thin, club shaped elongation of one of the major septa. Even in mature corallites sometimes axial structure is compact and shows no clear differentiation between lamellae and tabellae.

In longitudinal section the triareal arrangement of axial column, tabularium and dissepimentarium is rather clearly observable, though the differentiation between the latter two is sometimes not clear, owing to the development of elongate dissepiments and steeply inclined clinotabulae. Epitheca is moderately thick, sinuous and sometimes interrupted by gaps. Lonsdaleoid dissepiments are rather irregularly shaped, gently or steeply inclined towards the centre, facing their convex sides upwards and inwards. Elongate dissepiments are present. They are situated on the inner surface of dissepimentarium vertically, and are sometimes not well distinguishable from the usual dissepiments when the former are not very elongated. Clinotabulae are well developed, and are rather steeply inclined. The axial portion of a clinotabula often bends horizontally to form an s-shaped tabulae as a whole. Horizontal tabulae are often differentiated from clinotabulae. About 24 tabulae are counted immediately beside the axial column at a vertical distance of 5 mm. Axial column is often constructed densely, owing to the thickening on axial tabellae. The axial column occupies a rather narrow space, in which

a median plate and axial tabellae are discernible in some corallites. Calice is moderately deep.

Remarks: The present form resembles *Wentzelophyllum* (*Wentzelophyllum*) *volzi* from China. But in comparison with this Chinese form the present new species differs in having small corallites, less numerous major septa, more pronounced denticulation on epitheca, a narrow zone of lonsdaleoid dissepiments and steeply inclined clinotabulae. Moreover the former has an aphroid tendency in it.

ZHAO and CHEN (1963) recently described "*Stylidophyllum*" *volzi* var. *jingxianense*, which also has a similarity to the present species. Namely lonsdaleoid dissepimenta are ill developed, and denticles on epitheca are pointed in both forms. However, they are distinguished from each other by other characteristics above enumerated.

Partial vanishment of epitheca in the present form may be judged as denoting its belonging to *Polythecalis* rather than *Wentzelophyllum*. It certainly indicates the intermediate nature between the two genera. However, we are here stressing its general resemblance to the type species of *Wentzelophyllum* than to common forms of *Polythecalis*, in placing the species under the former genus.

The occurrence of the present form in association with *Pseudofusulina* and *Yatzengia* is somewhat noteworthy, because the assemblage clearly denotes its distinct Chihsian aspect.

Wentzelophyllum kinkiense (SAKAGUCHI et YAMAGIWA)

1958 *Stylidophyllum* sp., SAKAGUCHI & YAMAGIWA, p. 174, pl. 4, figs. 5a–b.
1963 *Stylidophyllum kinkiense* SAKAGUCHI & YAMAGIWA, pp. 10–11, pl. 2, figs. 1a–b, 2.
Holotype: IGOG 62002a, Osaka Gakugei University, Geol. Inst.
Type locality: Kannontoge, Sonobe-cho, Funai-gun, Kyoto Pref.
Geological horizon: *Triticites montiparus* subzone, viz. lower *Pseudoschwagerina* zone.

Remarks: In the present species tertiary septa are nearly lacking, but they may be only feebly developed on epitheca, which is notably thickened. So, at a glance the form looks quite similar to a *Yokoyamaella*, *Yokoyamaella* (Y.) *tertioseptata*. But the present form is provided with well developed, large lonsdaleoid dissepiments.

The species most closely resembles *Wentzelophyllum felseri* above described in many respects. Hence, we tentatively place the formnow in concern in *Wentzelophyllum*, instead of putting it under *Yokoyamaella*. These two forms differ from *Wentzelophyllum volzi* group, and may represent a side branch in *Wentzelophyllum*.

Wentzelophyllum intermedium (HUANG)

1963 *Stylidophyllum intermedium* HUANG, pp. 36–38, pl. 9, figs. 4a–b, 6.
Holotype: No. 3936, Geological Survey of China.
Type locality: No. 615 site, Chihsia-shan, Nanking, China.
Geological horizon: Chihsia limestone.

Remarks: The present species closely resembles species of *Polythecalis*, although it has a cerioid corallum instead of having aphroid. In this regard the species is, as HUANG suggested, " intermediate " between *Wentzelophyllum* and *Polythecalis*, though it is classed as a *Wentzelophyllum*.

Wentzelophyllum? persicum (DOUGLAS)

1936 *Wentzelella persica* DOUGLAS, p. 24, pl. 2, fig. 3.
1958 *Wentzelophyllum persicum*, HUDSON, pp. 186–187, pl. 34, figs. 1, 2, 5, 6.
Holotype: Slide S.P.R. 896.
Type locality: Kuh Gaikan, S. W. Iran.
Geological horizon: " *Parafusulina* " zone.
Geographic distribution: S.W. Iran and northern Iraq.

Specific diagnosis: Less developed lonsdaleoid dissepiments and tertiary septa.
Remarks: In the present form, a fairly large number of septa unite with wall, so that the non-septal peripheral area is rather narrow and locally developed in most corallites, in which lonsdaleoid dissepiments are accordingly less developed as a member of *Wentzelophyllum*. In this regard, the present species beyond doubt is akin to the genus *Ipciphyllum* rather than *Wentzelophyllum*. Further, the columella of the present form does not show the typical (lonsdaleoid) spider-web structure, as most species belonging to *Wentzelophyllum*.

However, the present form has definitely tertiary septa, although they are not numerous. In addition they are merely represented by very short and thin septal ridges attached to the wall.

Hence, we placed the present form in the genus *Wentzelophyllum* with some doubt. Fairly well developed clinotabulae and elongate dissepiments may be worthy of note in the present form. In addition, the wall is variable in thickness. It is locally very thin, while it is also fairly thick in some corallites.

Wentzelophyllum? gelikhanense sp. nov.

1958 "*Lonsdaleia*" *chaoi* var. HUDSON, p. 181, pl. 32, figs. 1, 2, 7–9, text-figs. 2, 3a–d.
Compared with 1932 *Stylidophyllum chaoi* HUANG, p. 73, pl. 7, fig. 3 (non *Stylidophyllum chaoi* HUANG in YOH and HUANG, p. 35).
Holotype: Specimen R. 41996 and sections R 42027 (a-e).
Type locality: Scree of the uppermost bed of *Michelinia* limestone, Geli-Khana section, Ora, North Iraq.
Age: "*Parafusulina*" zone.

Diagnosis: *Wentzelophyllum* like coral with very thin walls, provided with less numerous septal ridges. With only a few clinotabulae and elongate dissepiments. Median plate of axial structure is not entirely lacking but not prominent.
Remarks: The present species possesses elongate dissepiments besides clinotabulae. The mentioned elongate dissepiments are generally small in size and are very sporadically found immediately outside of the area occupied by clinotabulae. As it is easily recognized in HUDSON's figure 1 on plate 32, the elongate dissepiments are longitudinally arranged in the longitudinal section, with their convex sides facing inwards against somewhat obliquely arranged dissepiments of other kinds.

In addition, tertiary septa are also observable in this species but are not uniformly distributed throughout the corallites. In fact they are only locally found along walls as mere short septal ridges.

Nevertheless, when they appear, they are closely spaced and may have as many as twice the number of the minor and major septa in the same length. In other words, such septal ridges correspond not only to the major and minor septa respectively, but also to the interspace between these long septa. Thus, the presence of tertiary septa in this species is beyond doubt.

Meanwhile, the present form very closely resembles the Chinese form once described by HUANG under the name of *Stylidophyllum chaoi* and figured on his plate 7 as fig. 3, which is in reality specifically distinct from the holotype specimen originally termed as *chaoi*.

Actually, the former is akin to the latter in having rather thin walls providing thin and short (tertiary) septal ridges, but it may also be specifically distinct from the latter in having more complex and larger axial structure.

The present form may be comparable to the so-called *Stylidophyllum orientale*, an Iranian form, described and illustrated by DOUGLAS, in size and general feature of corallites. But the axial structure of the Iranian species seems to be more complex, provided with more numerous tabellae and more thicker median plate. Further, the Iranian form possesses slightly more numerous major septa than the present species.

Wentzelophyllum? jenningsi (DOUGLAS)

1936 *Stylidophyllum jenningsi* DOUGLAS, p. 15, pl. 2, figs. 7, 8; pl. 3, figs. 1, 2.
Holotype: Slide no. S.P.R. 1476, paratype, slide no. S.P.R. 873 specimen G.S.I. type no. 15910 and 15911.
Type locality: Tang-i-Chalati, Iran.
Horizon: "*Parafusulina*" zone.

Daignosis: *Wentzelophyllum* like coral with a rather thick wall and small columella.
Remarks: The present species provides distinct clinotabulae and elongate dissepiments. Hence, there is no doubt about its assignment to Waagenophyllidae instead of Lonsdaleidae.

The present form, however seemingly lacks in the distinct tertiary septa. Although very short and thin, septal plates are observable which are only locally developed between the major and minor septa in certain parts of corallite, illustrated by DOUGLAS on fig. 1 of plate 3.

Wentzelophyllum? orientale (DOUGLAS)

1936 *Stylidophyllum orientalis* DOUGLAS, p. 16, pl. 3, fig. 3.
Holotype: Slide no. S.P.R. 3388, specimen G.S.I. type no. 15912.
Type locality: Chal-i-Sheh, Southwesst Iran.
Geological horizon: "*Parafusulina*" zone.

Diagnosis: *Wentzelophyllum* like coral with rather thin wall, which does not provide any remarkable septal ridges, though not entirely lacking. Axial structure is densely constructed in which median plate is very thick.
Remarks: DOUGLAS neither described the longitudinal nature of the corallites of this species nor illustrated the longitudinal sections. However, the presence of very slender and short septal ridges on walls are locally indicated in the cross section illustrated by DOUGLAS. It may be accordingly reasonable to place it into genus *Wentzelophyllum* rather than *Stylidophyllum*. The present species is closely akin to the preceding species in many points, but differs from the former in having a thin wall.

Wentzelophyllum? douglasi, sp. nov.

1936 *Polythecalis* aff. *chinensis*, DOUGLAS, p. 16, pl. 3, fig. 4. (non *Lonsdaleia chinensis*

GIRTY, 1907).
Holytype: Slide no. B. 311, specimen G.S.I. type no. 15917.
Type locality: Tang-i-Shakari, Iran.
Geological horizon: "*Parafusulina*" zone.

Specific diagnosis: *Wentzelophyllum* like coral with relatively smaller corallites, in spite of having a number of major septa. Walls provide numerous septal ridges.
Remarks: The thin septal ridges resembling spines attached to the walls are very numerous. Comparing to the number of septa and these ridges, the latter far exceed than the former in number. Accordingly a certain number of these septal ridges may be in fact the tertiary septa, although very incipient in development.

The present form possesses walls which are hardly suppressed in any part of corallites and it cannot be accordingly placed in the genus *Polythecalis*, although the lonsdaleoid dissepiments are highly convex as in the case of *chinensis*. The present species is characteristic in having smaller corallites, of which the average diameter is about 9 mm, while it has about 30 major septa in it.

Wentzelophyllum? langpotangense, sp. nov.

1932 *Stylidophyllum chaoi*, HUANG, p. 73, pl 7, gfi. 3.
Non *Stylidophyllum chaoi* HUANG, in YOH and HUANG, 1932, p. 35, pl. 9, figs. 5a–b.
Type locality: Pass NW of Langp'ot'ang, Lipohsien, Kueichow.
Geological horizon: Chihsia limestone.

Diagnosis: *Wentzelophyllum* like coral with simple and narrow axial structure.
Remarks: Except for the nature of axial structure, the present species may be otherwise very close to *Wentzelophyllum? gelikhanense*. In the present form, tertiary septa are represented by septal ridges attached to walls which are rather pronounced.

Wentzelophyllum? tabasense, sp. nov.

Pl. 20, figs. 1–3.

Holotype: U.H.R. 18152.
Type locality: South fiank of Kuh-e-Jamal, southeast of Tabas, East Iran. Coll. Dr. J. STÖCKLIN.
Horizon: "*Parafusulina*" zone.

Diagnosis: *Wentzelophyllum* like coral without tertiary septa. Wall is fairly thick, zig-zagged in cross section. Elongate dissepiments and clinotabulae are

considerably well developed.

Description: Corallum compound. Corallites prismatic, perfectly cerioid. Average diameter of corallites is approximately 10–12 mm. Walls are fairly thick, and rather regularly zig-zagged in cross section.

Septal spines on walls always correspond to the major and minor septa in dispostion, and there are accordingly no trace of tertiary septa among them.

Septa are partly united with the wall, but are mostly free from the walls. They are of two orders. All of them are thin in the peripheral area, abruptly becoming thicker inwards from the inner wall and then tend again gradually to be thin towards the distal ends.

In the full grown stage, almost all the septa do not directly unite with the wall, and the peripheral area is occupied by large and small lonsdaleoid dissepiments on which short and slender crestal septa are locally developed.

The inner wall is composed of elongate dissepiments of smaller size, outer edges of clinotabulae, or the innermost lonsdaleoid dissepiments, all of them are slightly thickened both in cross and longitudinal section.

As many as 20–21 major septa are seen in the full grown stage. The minor septa regularly alternating with the major ones are not thinner than the latter in the intrathecal area, but decidedly much shorter. Both of them, however are not flexuous but rather straight even in the outer thecal area in the cross section.

Septa always stop growing short of the axial structure and never intrude into it. Even the couter septum does not directly unite with the median plate of the columella, which is long and always very thick.

Columella is various in configuration in the cross section, and mostly is loosely constructed, and small in size. Axial tabellae are slightly curved in general but sometimes are rather straight in the cross section. Normally, septal lamellae are less numerous, and irregularly disposed and are long and short at places. Thus the columella does not represent the typical lonsdaleoid (spider web) structure. Instead of this, the median plate is always distinct, and the columella shows a somewhat carcinophylloid appearance as a whole, even the septal lamellae are well developed. In such a case, lamellae are disposed somewhat perpendicular to the median plate, but not radially distributed in the cross section.

In the longitudinal section of most corallites, the peripheral zone is rather wide in which lonsdaleoid dissepiments are highly developed. In the outermost area of this zone, there are a single or two rows of elongate dissepiments, which are rather small, whose elongate-axis tends to be vertical. Clinotabulae are locally well developed, which unite with the well spaced and less cystose transverse tabulae.

Within a distance of 5 mm approximately 12 transverse tabulae are counted. They are sub-horizontal or sag slightly downwards. The axial column shows a typical cone in cone structure, in which the median plate is very thick and a little

flexuous. The axial tabellae are numerous, a little cystose and steeply ascending upwards.

Remarks: The present form possesses definite clinotabulae and elongate dissepiments at least in some part of the corallites. Accordingly it definitely belongs to Waagenophyllidae, instead of Lonsdaleidae, even if the other general features show the present species to be rather assignable into the Carboniferous " *Stylidophyllum* ".

However, the present species eventually lacks in any trace of the tertiary septa. Hence, in this regard, the present form strongly differs from the typical species belonging to the genus *Wentzelophyllum*.

Nevertheless, the present species seems to be more akin to *Wentzelophyllum* than to *Ipciphyllum* in many features of corallites, the presence of difinite inner wall, thickening of septa in the thecal region (inner wall), highly developed lonsdaloid dissepiments for instance, besides well developed median plate in the columella and somewhat carcinophylloid aspects of the columella. Thus we wish to place the present species in the genus *Wentzelophyllum* with a slight doubt, instead of *Ipciphyllum*, in spite of the lacking in tertiary septa in the present form.

Putting aside the lacking of septal ridges corresponding to the tertiary septa, the present species is closely akin to *Wentzelophyllum? gelikhanense* sp. nov. described by HUDSON from Northern Iraq, and *Wentzelophyllum? jenningsi* (DOUGLAS) of Southwestern Iran. However, the present form is specifically distinct from both Iraq and Iran species in having loosely constructed axial structure with distinct median plate. The present species also resembles *Wentzelophyllum? orientale* (DOUGLAS) but specifically differs from the latter in having a thick wall.

U. H. Reg. nos. 18152 (Holotype specimen), replica slides: 18285–18297.

The specimen was kindly put at our disposal by Dr. J. STÖCKLIN, Geological Survey of Iran to the senior author when he visited him in October, 1963 in Teheran.

(Note on " *Wentzelophyllum* " *sinense* FAN)

Wentzelophyllum sinense FAN* was lately described in Chinese by YÜ, LIN and FAN (1962) fom Sinkiang. According to them, the present form was found from the Middle Carboniferous deposits and it is very remarkable. Unfortunately the present form is, however so poorly illustrated that it is rather hard to tell its real characteristics. FAN compared the present species with " *Stylidophyllum* " *denticulatum*. We believe that the latter may be very near to *Szechuanophyllum* instead of *Wentzelophyllum* or " *Stylidophyllum* " but must be placed in the genus *Polythecalis*.

* Holotype: Co 263, Changchun Geological College, China. YÜ, LIN and FAN (1962), p. 26, pl. 4, figs. 5a, b.

FAN eventually did dot give any description concerning the presence of elongate dissepiments or tertiary or still higher orders of septa in this species, although he mentioned the existence of denticulate septal ridges on walls. Hence, there seems to be some doubt as to whether the present species really belongs to Waagenophyllidae. It may be possible that the present form belongs to " *Stylidophyllum* " or a certain cerioid member of *Taisyakuphyllum*, which has trabecular septa.

Genus ***Wentzelellites*** WU, 1963

1963 *Wentzelellites* WU, p. 494, pp. 500–501.
Type species: *Wentzelella salinaria* var. *sicula* MONTANARO-GALLITELLI, 1954.

Generic diagnosis: Corallum thamanstraeoid, partially cerioid. Tertiary septa present. Axial column is akin to that in *Carcinophyllum*. Other characteristics are similar to *Wentzelella*.
Remarks: Superficially thamnastraeoid corallum of the present genus reminds us of the character of *Lonsdaleiastraea*.

As MONTANARO-GALLITELLI noted the type species undoubtedly has a similarity to *Wentntzelella salinaria—wynnei* group, from which it is believed to have evolved in the course of the disappearance of wall structure. The genus has a carcinophylloid, anastomosing axial column with numerous major septa without any aphroid tendency in the corallum. On the other hand *Lonsdaleiastraea* has a partially aphroid corallum with typically small, compact axial column and less numerous major septa. So the distinction between two genera is clear though they both are believed to have evolved from *Wentzelella*, but in different lineages.

WU included the following species into his genus.

Wentzelella salinaria var. *sicula* MONTANARO-GALLITELLI, 1954
Wentzelella molengraaffi (GERTH), 1921
Wentzelella aff. *szechuanensis* (DOUGLAS), 1936 (sic.)

Wentzelella molengraaffi is, however, much closer to the type species of *Lonsdaleiastraea*, to which it is better transferred.

Wentzelella aff. *szechuanensis* (DOUGLAS, 1950: non HUANG, 1932) is in our opinion a synonym of *Wentzelella harrisoni* DOUGLAS, 1936. This species has lonsdaleiastraeimorph tendency, thus it may be included in the present genus of *Wentzelellites* here defined.

A form described and figured by SEN (1931 a, b) resembles the *Wentzelella salinaria-wynnei* group closely, but has gaps or " canals " in its wall structure, thus the corallum becomes partly thamnastraeoid. So the form is also to be included in *Wentzelellites*, though it stands just between *Wentzelella* and *Wentzelellites*.

The following three species are thus included in the genus *Wentzelellites* WU.

Wentzelellites sicula (MONATANARO-GALLITELLI)
Wentzelellites harrisoni (DOUGLAS)
Wentzelellites senni sp. nov.

Geographic distribution: Salt Range, Southwest Iran and Sicily.
Geologic distribution: In Salt Range the genus comes from Middle Productus limestone, while in Sicily it is yielded from Socio limestone. The geological range of the present genus is most probably the *Neoschwagerina* zone, and partly *Parafusulina* (?) zone.

Wentzelellites sicula (GALLITELLI)

1954 *Wentzelella slinaria* var. *sicula* GALLITELLI, p. 50, pl 2, figs. 1, 2, 2a–b.
Holotype: GALLITELLI collection, Museum of Palaeontology, The University of Modena, Italy.
Type locality: Pietra di Salomone, Socio valley, Sicily, Italy.
Geological horizon: Socio limestone, *Neoschwagerina* zone.

Remarks: It may be quite certain that this species was derived from *Wentzelella wynnei* group by missing wall structure, though partially.

The species now in concern has a rather thick wall, and well developed tertiary septa, and carcinophylloid axial column.

DEKONINCK once described *Lithostrotion basaltiforme* from Salt Range. (1863) His specimen is now stored at the Royal Scottish Museum of Edinburgh, and the junior writer had an opportunity to examine it. As a result the specimen turned out to be a *Wentzelellites*, and not a Carboniferous *Lithostrotion*. Walls strongly remain and are not wholly suppressed in this specimen. Axial columns are dense, are of *sicula* type, and tertiary septa are clearly observable. The diameter of the corallite is about 13 mm, and that of the axial column is about 2.5 mm.

Similar coral is also found in the British Museum collection. In the specimen walls are discontinued by the development of " canals ". This character is also discernible in *Yokoyamaella* (*Maoriphyllum*) *maoria* (LEED) as it was before described, and the character was already noticed by SEN in " *Lonsdaleia canalifera* " from the Salt Range. (See p. 186)

Anyhow it is quite obvious that these corals form a branch of *Wentzelella* in broad sense, and the character of missing walls was decidedly a step towards thamnastraeoid *Wentzelellites* from cerioid *Wentzelella*.

Wentzelellites senni, nov.

Text-fig. 6e.

1931 *Lonsdaleia canalifera*, SEN, p. 35, pl. 6, (non *Lonsdaleia canalifera* MANSUY 1913).
1931 *Waagenophyllum canalifera*, SEN, pp. 126–131, pl. IX, figs. 1–6, pl. X, figs. 1–2.

Diagnosis: *Wentzelellites* with fairly thick septa, in which quaternary septa are well developed besides tertiary septa; with a slight suppression or interruption on walls.

Remarks: As it was already stated in the remarks of *Wentzelella salinaria*, the present form is quite distinct from *Lonsdaleia canalifera* MANSUY which belongs to *Parawentzelella*. From *Wentzelella wynnei*, this species is also easily separable in not only showing clear interruption or suppression on continuation of walls, but also in having a far better developed quaternary septa.

In addition, the columella of the present form seems to be somewhat deviated from that of *Wentzelella wynnei*. In the present form, median plate is short but distinct, and septal lamellae are thick, while axial tabellae are thin and not typically developing, though not lacking entirely.

Type specimen: Holotype of the present species is here designated as the specimen figured by SEN (1931) on his plate VI, fig. 1. (F. 398 in the Presidency College collection).

Type locality: Namal gorge, Salt Range.
Geological horizon: Middle Productus limestone.

Wentzelellites harrisoni (DOUGLAS)

1936 *Wentzelella harrisoni* DOUGLAS, p. 24, pl. 2, fig. 4.
1950 *Wentzelella* aff. *szechuanensis*, DOUGLAS, p. 13, pl 2, fig. 5. (non *Wentzelella szechuanensis* HUANG, 1932).

Remarks: This species has numerous septa and thin walls, and it generally tends to become lonsdaleiastraeimorph through partial dissappearance of walls. In 1950, DOUGLAS also described a coral from Qashgai Sarhad, 4 miles, N. E. of Abadeh under the name of *Wentzelella* aff. *szechuanensis* HUANG.

The coral is described to have been collected from the Permian massive limestone there in association with *Waagenophyllum cinctum* DOUGLAS, *Wentzelella elegans* HUANG, *Stylidophyllum* sp., *Tachylasma* aff. *elongatum* GRABAU, *Chonetes glabra* GEINITZ, *Leptodus* aff. *tenuis* (WAAGEN), *Spirigerella harrisoni* DOUGLAS, *Wentzelella persica* DOUGLAS. Hence the age may be the *Neoschwagerina* zone in

rough estimation.

The coral described by DOUGLAS in 1950 shows the character to be slightly deviated from the typical form described in 1936 in having only a little thicker wall, but in the second specimen the lonsdaleiastraeimorphic trend is also discernible as in the holotype, and may be synonymous with each other.

Although no longitudinal sections were illustrated by DOUGLAS for this species, the tabularium with horizontal transverse tabulae may be doubtlessly wide, because the periaxial region of corallites is always well spaced in cross section.

Genus ***Polythecalis*** YABE et HAYASAKA, 1916

1916 *Polythecalis* YABE et HAYASAKA, p. 63 (71).
1932 *Polythecalis*, YOH and HUANG, p. 38.
1932 *Polythecalis*, HUANG, p. 77.
1950 *Lonsdaleia* (*Polythecalis*), WANG, p. 212.
1950 *Polythecalis*, TSENG, p. 30.
1955 *Polythecalis*, WANG, YÜ & YOH, p. 44.
1956 *Polythecalis*, HILL, F. 310.
1958 *Polythecalis*, HUDSON, p. 187.
1961 *Polythecalis*, FONTAINE, p. 180.
1962 *Polythecalis*, SOSHKINA & DOBROLYUBOVA (Partim), p. 344.
Type species: *Polythecalis confluens* YABE et HAYASAKA, 1916.

Generic diagnosis: Aphroid Waagenophyllidae with tertiary and quaternary septa. Thick and fairly long mural septa are locally retained.

Geographic distribution: Carnic Alps, Turkey, Iraq, Iran, Sumatra, Indochina, and China.
Geologic distribution: *Pseudoschwagerina* to *Yabeina* zone. Mostly *Pseudofusulina* zone, equivalent to Chinese Chihsian.

Included species: The following species may be included in *Polythecalis*. Species are arranged in chronological order, but they are not necessarily all valid species.

Polythecalis frechi (VOLZ), 1904
Polythecalis chinensis (GIRTY), 1907
Polythecalis confluens YABE et HAYASAKA, 1916
Polythecalis multicystosis HUANG, 1932
Polythecalis rosiformis HUANG, 1932
Polythecalis verbeekielloides HUANG, 1932
Polythecalis yangtzeensis HUANG, 1932
Polythecalis hochowensis HUANG, 1932
Polythecalis polygonalis HUANG, 1932

Polythecalis dupliformis HUANG, 1932
Polythecalis denticulatus HUANG, 1932
Polythecalis chinmenensis HUANG, 1932
Polythecalis? langpoensis HUANG, 1932
Polythecalis flatus HUANG, 1932
Polythecalis grayi DOUGLAS, 1936
Polythecalis variabilis (GERTH), 1938
Polythecalis? huangi TSENG, 1950
Polythecalis? wangi TSENG, 1950
Polythecalis? hexagonalis TSENG, 1950
Polythecalis? nankingensis TSENG, 1950
Polythecalis? bauryi FONTAINE, 1961
Polythecalis? khmerianus FONTAINE, 1961
Polythecalis? regularis FONTAINE, 1961
Polythecalis? biformis FONTAINE, 1961
Polythecalis simplex ZHAO et CHEN, 1963
Polythecalis irregularis ZHAO et CHEN, 1963
Polythecalis yangtzeensis crassiseptata ZHAO et CHEN, 1963
Polythecalis minor ZHAO et CHEN, 1963
Polythecalis abnormis ZHAO et CHEN, 1963
Polythecalis regularis ZHAO et CHEN, 1963 (non FONTAINE)
Polythecalis chaoxianensis ZHAO et CHEN, 1963
Polythecalis sp. (CHI, 1931)
Polythecalis sp. (HUDSON, 1958)

Remarks: There are not very many genera recorded in plocoid Waagenophyllidae. However, it is sometimes very difficult to say, whether a coral really belongs to a plocoid form or to a cerioid form, because in these forms the distinguishing point is merely the mode of development of wall, which is entirely a matter of degree.

Nevertheless, one can safely deduce true a systematic relationship between them in tracing transitional or intermediate form which can be classified under either of these two forms of corallum.

In the writers' opinion, *Polythecalis* is fairly easily separable from such allied forms as *Wentzelophyllum* for example, in having rather long mural spta, if the walls are locally retained. Besides, the polocoidal nature is more progressive in the present genus than the latter.

As it will be later described, corals being referable to the genus *Polythecalis* with certainty have not yet been found from the Japanese Permian.

Further, many species having been described by many scientists under the present generic name seem to vary extensively in nature from each other. Thus

our present revisions on all species are merely superficial.

Polythecalis tungliangensis HUANG may be considered to be a species of *Chusenophyllum*. (see under that genus).

HUANG (1932) and FONTAINE (1961) used many varietal names for forms of *Polythecalis* owing to the continuously variable nature of internal features in this genus. However taxonomically here we tentatively regard all of them to be of a specific rank. The genus should be fully restudied in order to confirm the validity of all of these species proposed to belong to *Polythecalis*. Two forms described by FOMITCHEV (1953) were obtained from the upper Carboniferous deposits of Donetz basin, and probably have nothing to do with Permian *Polythecalis*. They were possibly derived from *Lithostrotionella-Ivanovia* stock independently from Permian homoeomorphs, although it is quite difficult to discriminate morphologically the difference between these forms of different ages.

In Japan *Polythecalis japonica* was once described, but later this was regarded to be a form of " *Stylidophyllum* ", which had no tertiary septa. One more species doubtfully assigned to the genus was described by SAKAGUCHI and YAMAGIWA (1958) from the *Pseudofusulina* zone in Central Japan. The specimen seems to be badly recrystallized, and prevents detailed observation.

In all probability, the forms now in question, cannot be viewed with certainty to be assignable into the present genus.

TSENG (1950) considered " *Stylidophyllum* " *denticulatum* HUANG to be a *Polythecalis*. We also agree with him in this regard because the walls of the present form are getting thin. Besides the peripheral buds are also well illustrated and the present form has quaternary septa.

However, in our opnion, the Upper Permian " *Polythecalis* " described by TSENG (1950) seem to require further revision on their generic status. They are *Polythecalis huangi* TSENG, *P. wangi* TSENG, *P. hexagonalis* TSENG and *P. nankingensis* TSENG. All of them seem to us to be rather closer to the genus *Wentzelophyllum*, instead of *Polythecalis*.

On the other hand " *Stylidophyllum* " *variabile* GERTH (1938) is much closer to *Polythecalis* than the preceding species. GERTH's figure 2 of this species is not included herein, because we think it a somewhat vesicular modification of *Wentzelella caracorumensis* GERTH. " *Stylidophyllum* " *variabile* shows a similarity to *Polythecalis* cfr. *japonica* (HUDSON, 1958) and *Wentzelloides maiyaensis*, and the walls are partially suppressed.

Beside these species listed and mentioned above, DOUGLAS (1950) reported *Polythecalis* sp. from Iran. This may also be a derivative from " *Stylidophyllum* " *volzi* group.

Moreover, the species described by FONTAINE from Viet Nam under the generic name of *Polythecalis* seem to involve problems about their generic position. For instance, *Polythecalis bauryi* FONTAINE may be definitely closer to *Wentzelella* or

Szechuanophyllum than *Polythecalis* in our opinion. Anyhow, the present species should be eliminated from the genus *Polythecalis*.

Polythecalis khmerianus FONTAINE, *P. khmerianus* var. *regularis* FONTAINE and *Polythecalis khmerianus* var. *biformis* FONTAINE closely resemble each other. All of them have numerous septa almost reaching the walls, but lonsdaleoid dissepiments are less numerous and very small in size. They may be more nearly akin to the genus *Wentzelella* than *Polythecalis*. FONTAINE's forms have however walls partly vanished. They cannot be accordingly placed into *Wentzelella* without hesitation.

On the other hand, there may be some possibility in which the FONTAINE's species and its varietal form belong to *Wentzelloides*. However, in the Viet Nam forms, quaternary septa seem to be lacking.

Anyhow, it is almost certain, that the FONTAINE's forms above described are not entirely congeneric with the typical Chinese forms belonging to the genus *Polythecalis*.

If all such generically doubtful species mentioned above were to be taken from consideration, the geologic range of the genus *Polythecalis* would be confined from the *Pseudoschwagerina* zone to the *Parafusulina* zone. This would seem rather reasonable to us.

Lonsdaleia frechi was described by VOLZ from Padangar highland in Sumatra and this species is safely assignable into the genus *Polythecalis*. The fauna in which the present coral was included was stated by VOLZ to be the Upper Carboniferous. This is not true however, because VOLZ also described *Sumatrina annae* from the collection brought back from Padangar. It may be eventually Permian in age. Nevertheless, the synchronism of the present coral and *Sumatrina annae* is not guaranteed at all, as far as the VOLZ's description is concerned. The age of *Polythecalis frechi* can thus possible slightly be older than *Sumatriha annae*.

Polythecalis frechi (VOLZ)

1904 *Lonsdaleia frechi* VOLZ, p. 100, figs. 32–34.
Non *Lonsdaleia* (*Waagenophyllum*) *frechi*, OZAWA, 1925.
Syntype: Figured specimen(s): Figures 32–34, FRECH, 1904.
Type locality: Padangar highland, Sumatra.
Geological age: Unknown.

Polythecalis chinensis (GIRTY)

1907 *Lonsdaleia chinensis* GIRTY, p. 37.

1913 *Lonsdaleia chinensis*, GIRTY, p. 311, pl. 27, figs. 1–3.
1932 *Polythecalis chinensis*, YOH & HUANG, p. 38, pl. 4, figs. 2–3.
1932 *Polythecalis chinensis*, HUANG, p. 81.
Non *Polythecalis* aff. *chinensis*, DOUGLAS, 1955.
1955 *Polythecalis chinensis*, WANG, YÜ and YOH, p. 45, pl 20, figs. 5–6.
Syntype: Figures 1–3, pl. 27, GIRTY, 1913, p. 45, pl. 20, figs. 5, 6.
Type locality: Near Ta-ning-hien, East Ssi-ch'uan, China.
Geological horizon: Wushan limestone (Middle to Upper Chihsian-*Pseudofusulina* zone) see HUANG, 1932.

Polythecalis confluens YABE et HAYASAKA

1916 *Polythecalis confluens* YABE & HAYASAKA, p. 65 (73).
1920 *Polythecalis confluens*, YABE & HAYASAKA, pl. 11, figs. 1a, b.
Holotype (?): Figures 1a & b, pl. 11, YABE & HAYASAKA, 1920, Tohoku Univ. Sendai, Japan.
The locality: Ho-shan, Ton-ch'uan-hsien (Fui-tse), Yunnan, China.
Geological horizon: " *Tetrapora* " zone, Chihsian (fide LANG, SMITH & THOMAS, 1940).

Polythecalis sp.

1931 *Stylidophyllum* sp., CHI, p. 44, pl. 3, fig. 5.
1935 *Stylidophyllum* sp. CHI, listed only in p. 7.
Locality: Hill, northeast of Lochiotang, Chanyihsien, Yunnan. Loc. no. S2 2, no. 1, Coll. by V. K. TING, Cat. G.S.C. no. 3997.
Geological age: Lower Permian, *Pseudoschwagerioa* zone.

Remarks: Although CHI in 1931 once described the present form to have been collected from the limestone belonging to the Weiningian system in Yunnan, he later revised (1935) his statement and reported that it was actually found in the " Uralian " formation. The age, we think, however may be the Lower Permian, since in Yuunan the marine Upper Carboniferous seems almost lacking. The Upper Carboniferous or the so-called Uralian formation there seems to be the Lower Permian or *Pseudoschwagerina* age, so far as available references for us in this respect are concerned.

The present form provides undoubtedly tertiary septa including creatal septa. Walls are partly suppressed. In addition, lonsdaleoid dissepiments are highly spherical. Hence, the present form should be assigned into the genus *Polythecalis*, instead of " *Stylidophyllum* " or *Wentzelophyllum*.

Polythecalis verbeekielloides HUANG

1932 *Polythecalis verbeekielloides* HUANG, in YOH & HUANG, p. 41, pl. 10, figs. 2a–b.
1950 *Polythecalis verbeekielloides*, TSENG, p. 35, listed only.
Holotype: No. 3929.
Type locality: Chihsia shan, Nanking, China.
Geological horizon: Chihsia limestone.

Polythecalis rosiformis HUANG

1932 *Polythecalis rosiformis* HUANG, in YOH & HUANG, p. 42, pl. 10, figs. 1a–c.
? 1939 *Polythecalis rosiformis*, HERITSCH, p. 175, pl. 1, figs. 1, 6–9.
1950 *Polythecalis rosiformis*, TSENG, p. 35, listed only.
1961 *Polythecalis rosiformis*, FONTAINE, p. 183, pl. 24, figs. 11–12.
Holotype: No. 3930.
Type locality: Chi-lung-shan, Ho-chou, Anhui, China.
Horizon: Chihsia limestone.

Polythecalis multicystosis HUANG

1932 *Polythecalis multicystosis* HUANG, in YOH & HUANG, p. 44, pl. 7, figs. 1a–b, 3–4; pl. 10, fig. 3.
1950 *Polythecalis multicystosis*, TSENG, p. 35, listed only.
Holotype: No. 3831.
Type locality: Chi-lung-shan, Ho-chou, Anhui, China.
Horizon: Chihsia limestone.

Polythecalis yangtzeensis HUANG

1932 *Polythecalis yangtzeensis* HUANG, p. 83, pl. 7, fig. 5; 0l. 8, figs. 1–2.
1950 *Polythecalis yangtzeensis*, TSENG, p. 35, listed only.
1955 *Polythecalis yangtzeensis*, WANG et al., p. 44, pl. 20, figs. 1, 2.
Holotype: No. 1377.
Type locality: Chiuts'aitung, Hsishuihsien, Kueichow, China.
Horizon: Chihsia limestone.
Remarks: This species was also identified from Chihsiashan and Gnomeishan.

Polythecalis hochowensis HUANG

1932 *Polythecalis yangtzeensis* var. *hochowensis* HUANG, p. 85, pl. 8, figs. 3, 4.
1933 *Polythecalis yangtzeensis* var. *hochowensis*, YOH, pl. 1, figs. 4a, b.
Syntype: No. 3883, 3884.
Type localities: South of Nankao, Ch'anghsinghsien, Chekiang and Chilungshan, Hohsien, Anhui, China.
Horizon: Chihsia limestone.

Remarks: TSENG (1950) considered this species to belong to " *Stylidophyllum* ", but we cannot accept his view. A specimen from Chilungshan is not unlike *Polythecalis rosiformis* from the same locality.

Polythecalis polygonalis HUANG

1932 *Polythecalis yangtzeensis* var. *polygonalis* HUANG, p. 86, pl. 8, fig. 5 ; pl. 9, fig. 5.
1950 *Polythecalis yangtzeensis* var. *polygonalis*, TSENG, listed only in p. 35.
Holotype: No. 3885.
Type locality: A place between Maanshan and a hut to the east of Tuyunhsien, Kueichow, China.
Horizon: Chihsia limestone.

Polythecalis chinmenensis HUANG

1932 *Polythecalis chinmenensis* HUANG, p. 88, pl. 9, fig. 2.
1950 *Polythecalis chinmenensis*, TSENG, p. 35, listed only.
Holotype: No. 3887.
Type locality: Huchiatsi, Chinmenhsien, Hupeh, China.
Horizon: Chihsia limestone.

Polythecalis? langpoensis HUANG

1932 *Polythecalis langpoensis* HUANG, p. 90, pl. 9, fig. 3.
1950 *Polythecalis langpoensis*, TSENG, p. 35, listed only.
Holotype: No. 3888.
Type locality: Pass N. W. of Langp'ot'ang, Lipohsien, Kueichow, China.
Horizon: Basal part of the Chihsia limestone.

Polythecalis dupliformis HUANG

1932 *Polythecalis dupliformis* HUANG, p. 86, pl. 9, fig. 1.
1950 *Polythecalis dupliformis*, TSENG, p. 35, listed only.
Holotype: No. 3886.
Type locality: Between Chiuts'situng and Singch'ang, Hsishuihsien, Kueichow, China.
Horizon: Middle part of the Chihsia limestone.

Polythecalis denticulatus (HUANG)

Text-fig. 7b.

1932 *Stylidophyllum denticulatum* HUANG, p. 73, pl. 7, fig. 1.
Non *Stylidophyllum denticulatum*, KOSTIC-PODGORSKA, 1954, pp. 115–119.
1950 *Polythecalis denticulatum*, TSENG, listed in page 35.
Type specimen: Geol. Surv. China, Cat. no. 3878.
Type locality: According to HUANG it came from the so-called lower part of the Lower Permian limestone, 1 li N. of Kuan-shang, Tu-yun-hsien, Kueichow in association with *Tetrapora elegantula*, Loc. No. Tw 24.
Geological horizon: *Pseudofusulina* zone.

Remarks: This species is quite peculiar indeed and it is very hard to decide in what genus it should be placed. The wall of the present form does not seem to be the typical beading type but rather the thin septal wall type. Lonsdaleoid dissepiments are well developed in this species, and the cyctose zone is very wide.

Further, the walls are locally suppressed. Hence, the present form has a number of septa reaching the wall which grow towards the axial structure with or without interruptions, even in the full grown stage. In addition crestal septa are very abundant in almost every corner of the cystose zone. Thus, the present form may be also concluded to have an intermediate nature between the genus *Polythecalis* and *Wentzelophyllum*.

Nevertheless, the present form would be best placed in the genus *Polythecalis*, since there are undoubtedly quaternary septa, besides tertiary septa and walls are partly vanished.

Polythecalis flatus HUANG

1932 *Polythecalis flatus* HUANG, p. 88, pl. 10, fig. 6.

1950 *Polythecalis flatus*, TSENG, listed only in p. 35.
Holotype: No. 3897.
Type locality: Between Chiuts'aitung and Singch'ang, Hsishuihsien, Kueichow, China.

Polythecalis grayi DOUGLAS

1936 *Polythecalis grayi* DOUGLAS, p. 17, pl. 2, fig. 5.
? 1950 *Polythecalis* aff. *grayi*, DOUGLAS, p. 15, pl. 2, fig. 8.
Holotype: Slide No. B. 317, Specimen G.S.I. no. 15914.
Type locality: Tang-i-La Mir, Gahkum area Iran.
Geological age: May be Chihsian.

Polythecalis variabilis (GERTH)

1938 *Stylidophyllum variabile* var. *a*, GERTH, p. 233, pl. 15, figs. 4, 5, 6.
1938 *Stylidophyllum variabile* var. *b*, GERTH, p. 234, pl. 15, figs. 2, 3.
Syntype: M. 48, 46, 52, H. DE TERRA Coll.
Type locality: Kyam in Karakorum.
Geological age: "*Parafusulina*" zone? (*Lyttonia* limestone.)

Remarks: The present species is variable in septal number, thickness of wall and development of lonsdaleoid dissepiments. However, the columella of the present form is always small and simply constructed. In this respect, the present form strongly reminds us of *Wentzelloides maiyaensis*. Further, the major and minor septa are relatively less numerous, which are locally united with wall. In addition to this, there are locally developed quaternary septa besides tertiary septa.

Nevertheless, the present form cannot be placed in the genus *Wentzelloides*, since lonsdaleoid dissepiments are fairly well developed in the present genus.

The last mentioned fact may suggest the possibility that the present species belongs to the genus *Polythecalis*. Further, in the present form, there is no doubt about the suppression of wall in certain parts of the corallites.

Polythecalis? huangi TSENG

1950 *Polythecalis huangi* TSENG, p. 37, pl. 1, figs. 1a–b.
Holotype: No. 6992.
Type locality: Kungshan, Nanking, China.
Horizon: Upper Chihsia limestone.

Polythecalis? wangi TSENG

1950 *Polythecalis wangi* TSENG, p. 38, pl. 1, figs. 2a–b.
Holotype: no. 6993.
Type locality: Kungshan, Nanking, China.
Horizon: Upper Chihsia limestone.

Polythecalis? hexagonalis TSENG

1950 *Polythecalis hexagonalis* TSENG, p. 39, pl. 2, figs. 1a–b.
Holotype: no. 6994.
Type locality: Kungshan, Nanking, China.
Horizon: Upper Chihsia limestone.

Polythecalis? nankingensis TSENG

1950 *Polythecalis nankingensis* TSENG, p. 40, pl. 2, figs. 2a–b.
Holotype: Cat. No. 6995.
Type locality: Kungshan, Nanking, China.
Horizon: Upper Chihsia limestone.

Polythecalis? sp.

1958 *Polythecalis* sp. cf. *P. japonica*, HUDSON, p. 187, pl. 35, figs. 1, 2, 7.
Specimen: Brit. Mus. R. 42018 (three pieces) and sections a, b, and c. *Wentzelella* limestone, Harrur section, Chalki, northern Iraq.

Remarks: The present form is characteristic in having a rather thick wall decorated by thick septal ridges including tertiary septa, although the walls occasionally become thin and have completely vanished in certain parts of the corallites. Columella is small and rather simply constructed. Major and minor septa are remarkably few.

We are quite certain that the present form is obviously distinct from the Japanese form, once called by YABE and MINATO under the name of *Polythecalis japonica*.

Quaternary septa may be present in the present form, though they are by no means dominantly observable.

Polythecalis bauryi FONTAINE

1961 *Polythecalis Bauryi* FONTAINE, p. 181, pl. 23, fig. 6; pl. 24, fig. 7.
Holotype: No. 273, FONTAINE collection.
Type locality: Phnom Sway, Sisophon region, Cambodge.
Geological age: *Yabeina* zone?

Polythecalis? khmerianus FONTAINE

1961 *Polythecalis khmerianus* FONTAINE, p. 182, pl. 23, fig. 4, 8, 10; pl. 26, figs. 1, 8.
Holotype: No. 369, FONTAINE collection.
Type locality: Phnom Sway, Sisophon, Cambodge.
Geological orizon: *Yabeina* zone?

Polythecalis? regularis FONTAINE

1961 *Polythecalis khmerianus* var. *regularis* FONTAINE, p. 183, pl. 23, figs. 2–3, 9; pl. 24, fig. 2; pl. 27, figs. 7, 8.
Syntypes: Nos. 21, 715.
Localities: Phnom Sway, Phnom Tup and Phnom An-Cheang, all in Sisophon region, Cambodge.
Horizon: *Yabeina* zone?

Polythecalis? biformis FONTAINE

1961 *Polythecalis khmerianus* var. *biformis* FONTAINE, p. 183, pl. 23, figs. 4, 5, 10; pl. 24, figs. 1, 3, 5., 9
Holotype: No. 705, FONTAINE collection.
Type locality: Phnom Takream, Battambang region, Cambodge.
Horizon: *Yabeina* zone?

Polythecalis simplex ZHAO et CHEN

1963 *Polythecalis simplex* ZHAO & CHEN, p. 383, 395–6, pl. 2, figs. 31–b.
Holotype: Nos. 14207–8, Palaeont. Inst., Acad. Sinica, Nanking, China.
Type locality: Dafengchun, Nansan, Anhui, China.
Geological horizon: Upper part of Chihsia limestone.

Polythecalis irregularis ZHAO et CHEN

1963 *Polythecalis irregularis* ZHAO & CHEN, pp. 383–384, 396, pl. 1, figs. 3a–b.
Holotype: Nos. 14195–6, Palaeont. Inst., Acad. Sinica, Nanking, China.
Locality: Same as the preceding species.
Geological horizon: Same as the preceding species.

Polythecalis yangtzeensis crassiseptata ZHAO et CHEN

1963 *Polythecalis yangtzeensis crassiseptata* ZHAO & CHEN, pp. 384–5, 296–7, pl. 1, figs. 4a–b.
Holotype: Nos. 14197–8, Palaeont. Inst., Acad., Sinica, Nanking, China.
Locality: Same as the preceding species.
Geological horizon: Same as the preceding species. (*Polythecalis yangtzeensis* zone in Chihsian).

Polythecalis abnormis ZHAO et CHEN

1963 *Polythecalis abnormis* ZHAO & CHEN, pp. 385, 398, pl. 2, figs. 1a–b.
Holotype: Nos. 14203–4, Palaeont. Inst., Acad. Sinica, Nanking, China.
Locality: Same as the preceding species.
Horizon: Same as the preceding species.

Polythecalis sp. nov.

1963 *Polythecalis regularis* ZHAO & CHEN, pp. 385–6, 398–9, pl. 2, figs. 4a–b. (non FONTAINE).
Holotype: Nos. 14209–14210, Palaeont. Inst., Acad., Sinica, Nanking, China.
Horizon: *Hayasakaia elegantula* zone of Chihsian.
Locality: Same as the preceding species.

Remarks: The specific name of *Polythecalis regularis* has already been used by FONTAINE. *Polythecalis regularis* ZHAO et CHEN is therefore a junior homonym of the FONTAINE's species, and has to be abandoned. A new name for this Chinese form would be necessary for replacing the former name.

Polythecalis minor ZHAO et CHEN

1963 *Polythecalis minor* ZHAO & CHEN, pp. 384–5, 397, pl. 2, figs. 2a–b.
Holotype: Nos. 14205–6, Palaeont. Inst., Acad. Sinica, Nanking, China.
Locality: Same as the preceding species.
Horizon: *Polythecalis yangtzeensis* zone, Chihshian.

Polythecalis chaoxianensis ZHAO et CHEN

1963 *Polythecalis chaoxianensis* ZHAO & CHEN, p. 386, 399, p. 3, figs. 4a–b.
Holotype: Nos. 14219–14220, Palaeont. Inst., Acad. Sinica, Nanking, China.
Type locality: Guishan, Chaoxian, Anhui, China.
Geological horizon: Chihsian.

(Note on *Polythecalis? meandroides* SAKAGUCHI & YAMAGIWA)

SAKAGUCHI and YAMAGIWA (1958) described corals from the Permian formation of the Tamba region, central Japan.

Among these forms, *Polythecalis? meandroides* S. & Y. requires further comment.

In our opinion *Polythecalis? meandroides* does not belong to *Polythecalis*, but is related to " *Wentzelella* " *sekii*, which is a cerioid representative of Carboniferous *Taisyakuphyllum*. What SAKAGUCHI and YAMAGIWA considered to be the suppression of wall in this coral is nothing but the mode of intracalicular increase, of which new " buds " are springing from the " mother " corallites.

We consider *Polythecalis? meandroides*, together with " *Stylidophyllum kameokense* " and " *Stylidophyllum quadratum* ", to comprise a group which is related to fasciculate *Taisyakuphyllum* in having tertiary septa, lonsdaleoid dissepiments, clinotabularium, trabecular septa and cerioid corallum, and is certainly distinguishable from typical *Polythecalis*.

We suggest it is possible that these three corals, including *Polythecalis meandroides* are all derived fossils from Carboniferous into Permian deposits.

Genus ***Chusenophyllum*** TSENG, 1948

1929: *Vesotabularia* YÜ (nom. nud.) in YÜ & SHU, pp. 50, 106.

1948: *Chusenophyllum* TSENG, P. 1.
Type species: *Chusenophyllum paeonoidea* TSENG, 1948.

Generic diagnosis: Aphroid Waagenophyllidae without any trace of wall structure. Otherwise internal characters are the same with those in the genus *Polythecalis*.

Geologic distribution: Permian (ueper Chihsian, *Pseudofusulina* zone).
Geographic distribution: China.

Included species:

Chusenophyllum paeonoidea TSENG, 1948
Chusenophyllum asteroidea TSENG, 1948
Chusenophyllum breviseptatum TSENG, 1948

The genus, as we think, certainly originated from forms of *Polythecalis* in losing wall completely. Not only the morphological features but also geologic and geographic distribution of the genus does suggest this relationship.

The genus, on the other hand resembles very closely the Carboniferous *Ivanovia*, to which it may be a homoemorph.

Aside from the species listed above there have been known some species close to the genus. *Polythecalis tungliangensis* (YÜ) HUANG (1932) is certainly a member of *Chusenophyllum*. Also *Polythecalis chinensis* mutation a, *P. flatus* and *P. multicystosis* stand closer to *Chusenophyllum* in view of the almost complete suppression of wall in them. The nature is, however, a matter of degree, of course.

Chusenophyllum tungliangensis (YÜ in HUANG)

1932: *Polythecalis multicystosis* var. *tunliangensis* HUANG, p. 91, pl. 9, fig. 4; pl. 11, figs. 1, 2.
1929: *Vesotabularia tungliangensis* YÜ, nom. nud. p. 50, p. 106.
Holotype: Cat. no. 3902, YÜ collection.
Type locality: T'unliangchai, Nanchangsien, Hupeh, Clian.
Geological horizon: Chihsia limestone.

Remarks: YÜ listed *Vesotabularia tunliangensis* in his paper on stratigraphy in cooperation with SHU (1929). Since neither description nor illustration was given for the species, *Vesotabularia tunliangensis* was a nomen nudum, YÜ's specimen was, however reexamined by HUANG, who considered the species to be a *Polythecalis*. (HUANG, 1932)

As before stated, the species now in question is better to be treated as a *Chusenophyllum* in our opinion.

Very recently, YÜ too suggested the identity between his *Vesotabularia* and *Chusenophyllum* TSENG. (YÜ. 1962)

Chusenophyllum paeonoidea TSENG

1948 *Chusenophyllum paeonoidea* TSENG, p. 2, pl. 1, figs. 1a-1c.
Holotype: Cat. no. 6944, Geol. Surv, China.
Type locality: Loc. no. Nf 47–104, Kungshan, Nanking, China.
Geological horison; Upper most bed of Chihsia limestone.

Chusenophyllum asteroidea TSENG

1948 *Chusenophyllum asteroidea* TSENG, p. 2, pl. 1, figs. 2a-b.
1955 *Chusenophyllum asteroidea*, WANG et al, p. 45, pl. 20, figs. 7, 8.
Holotype: Cat. no. 6945, Geol. Surv. China.
Type locality: Loc. no. Nf 48–104, Nanking hills, Nanking, China.
Geological horizon: Upper bed of Chihsia limestone.

Chusenophyllum breviseptatum TSENG

1948: *Chusenophyllum breviseptatum* TSENG, p. 3, pl. 1, figs. 3a–b.
Holotype: Cat. no. 6946, Geol. Surv. China.
Horizon and Locality: Same as the preceding.

Addenda:

Wentzelophyllum jingxianense (ZHAO et GHEN)

1963 *Stylidophyllum volzi* subsp. *jingxianense* ZHAO et CHEN, p. 382, 395, pl. 1, figs. 5a–b.
Holotype: Nos. 14199–14200, Palaeont. Inst. Acad. Sinica, Nanking, China.
Type locality: Shibishan, Yangongtan, Jingxian, Anhui, China.
Horizon Chihsia limestone.
Remarks: See remarks on *Wentzelophyllum hayasakai.*

Postscript:

After the completion of manuscript appeared the following publication.

H. IGO (1964): Permian Fossils from Northern Pahang, Malaya. Japanese Jour. Geol. & Geogr., vol. 35, no. 1, pp. 57–71, pl. 2.

In this article a new species of Waagenophyllidae, *Wentzelella malayensis* was described and figured. From evidences of associated fusulinids the age of this coral may be *Neoschwagerina* to *Yabeina* zone. And this form appears to have no tertiary septa, while it has weakly developed lonsdaleoid dissepiments and canals. Therefore the assignment of the present form to *Wentzelella* may be inconceivable. This may be a species of *Parawentzelella* FONTAINE.

While our joint paper was in press we received the following article in which a number of waagenophyllids were dealt with.

W. GRÄF (1964): Permische Korallen aus dem Zagros-Gebirge, dem Elburz und aus Azerbeidjan, Iran. Senckenbergiana Lethaea, Bd. 45, S. 381–432, Taf. 34–41.

Our examination upon GRÄF's illustration for waagenophyllids reveals the following revision of GRÄF's identification.

Waagenophyllum (*Liangshanophyllum*) *wengchengense* (HUANG)
=*Pseudohuangia* with slight doubt.
Waagenophyllum (*Waagenophyllum*) *indicum* (WAAGEN et WENTZEL)
=*Pseudohuangia* sp.
Polythecalis rosiformis HUANG
=*Chusenophyllum* sp.
Stylidophyllum kueichowense HUANG
=*Stylidophyllum kueichowense* of DOUGLAS, 1936
=*Wentzelophyllum* sp.
Stylidophyllum orientale DOUGLAS
=*Wentzelophyllum? orientale* (DOUGLAS)
Wentzelella timorica (GERTH)
=*Ipciphyllum* cfr. *flexuosa* HUANG

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* The present bibliography is intended to cover literatures concerned to descriptions and discussions on waagenophyllid corals. But many stratigraphic papers are here excluded from the list. Amongst literatures listed (124 items in all) we could not refer to some 8 of them.

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PLATES AND EXPLANATIONS

Explanation of plate 1

Types of Walls of massive Waagenophyllidae.

Fig. 1. Thin wall strengthened by mural septa=septal wall.
Yokoyamaella (Yokoyamaella) yokoyamai (OZAWA), III 63, OZAWA collection, Tokyo University.

Fig. 2. Thin wall. *Parawentzelella (Miyagiella) miyagiensis*, sp. nov. UHR 18274 b.

Fig. 3. Septal wall. *Wentzelloides maiyaensis* YABE et MINATO, UHR 15234

Fig. 4. Thick wall. In this case the thickened outer layer of wall is not always visible, because of weak contrast of photograph. Yet thickened wall can be observed in some part of corallites in this figure· *Parawentzelella (Miyagiella) miyagiensis*, sp. nov. UHR 18273.

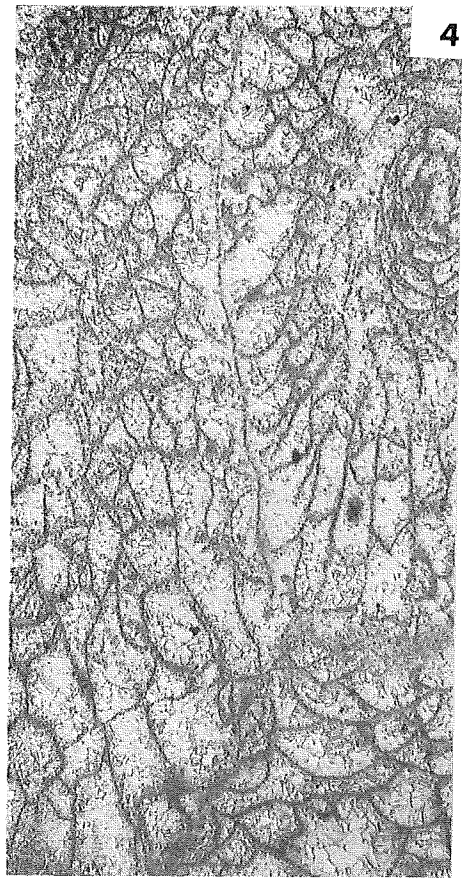
Fig. 5. Septal wall. *Wentzelella (Szechuanophyllum) kitakamiensis* YABE et MINATO, UHR 15158.

Fig. 6. Septal wall. *Yokoyamaella (Yokoyamaella) yokoyamai* (OZAWA), UHR 18148 a.

Fig. 7. Septal wall of beading type. *Wentzelophyllum felseri*, sp. nov. UHR 17880 b.

Fig. 8. Thin wall. *Ipciphyllum laosense* (PATTE), UHR 18177.

Figures 1 & 2 are longitudinal sections, while figures 3 to 8 are transverse (cross) ones. (All figures twenty times natural size.)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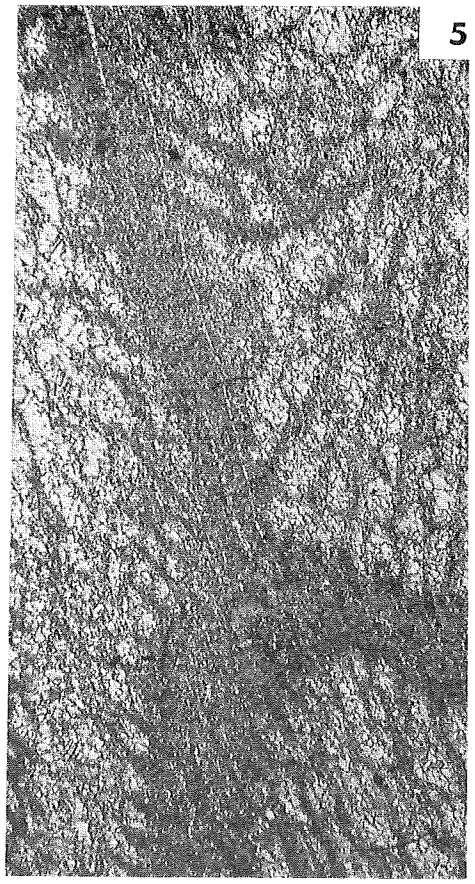
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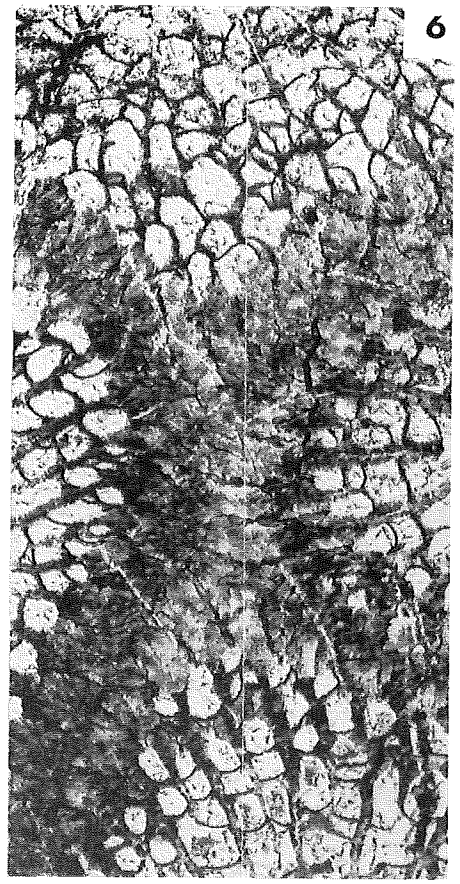
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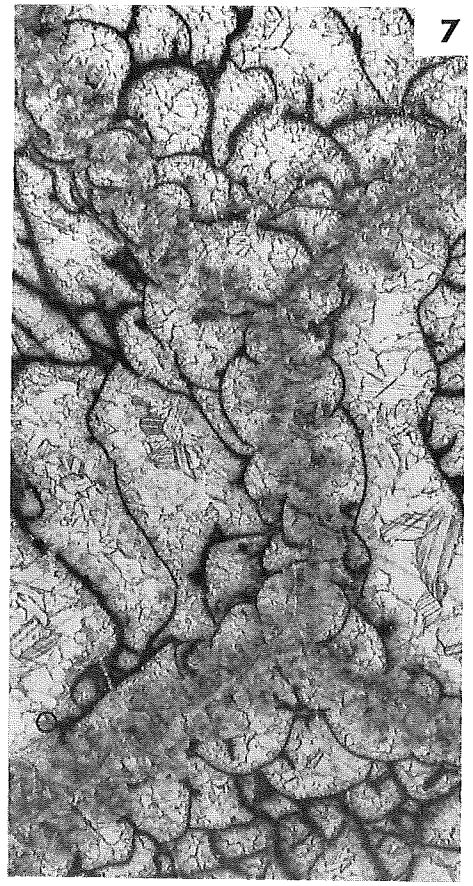
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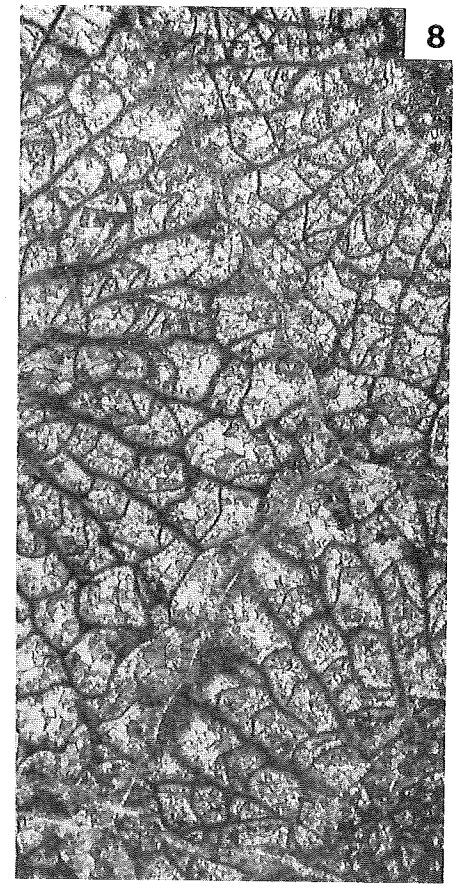
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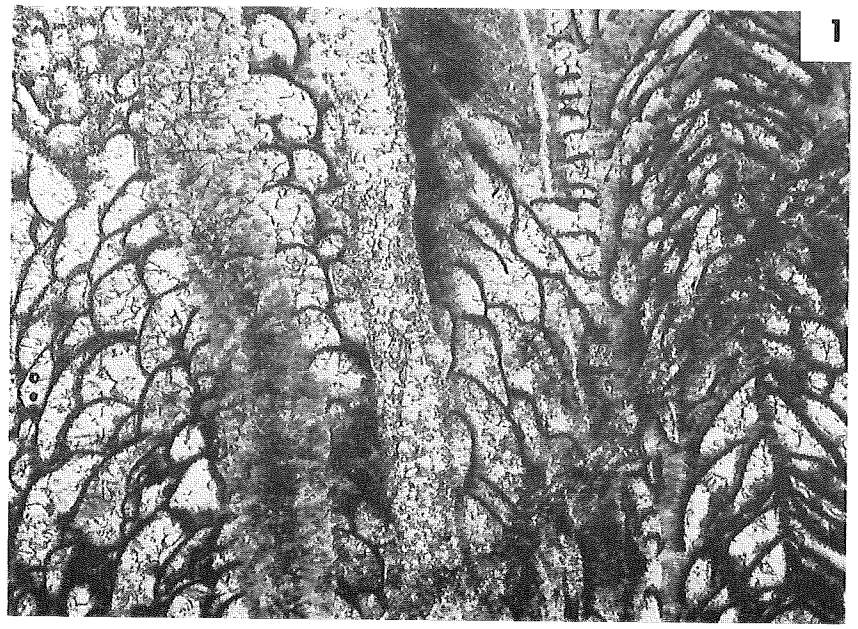
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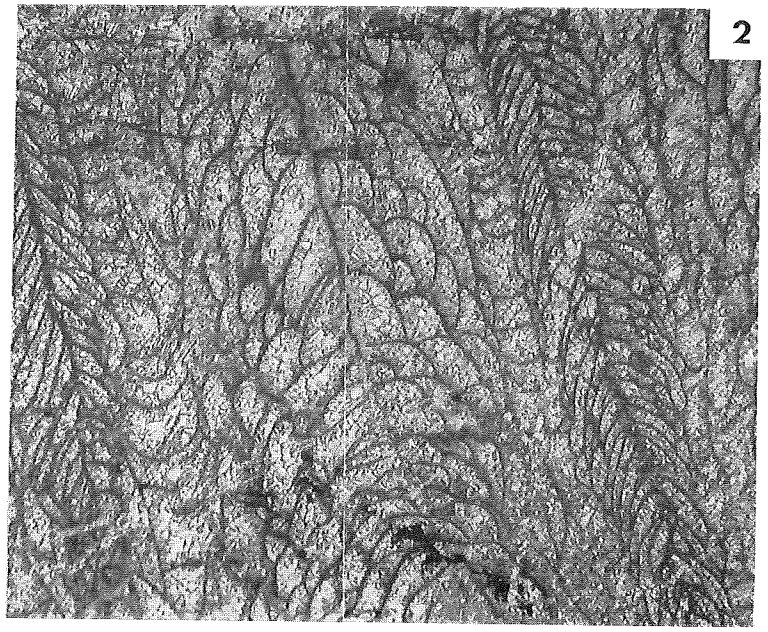
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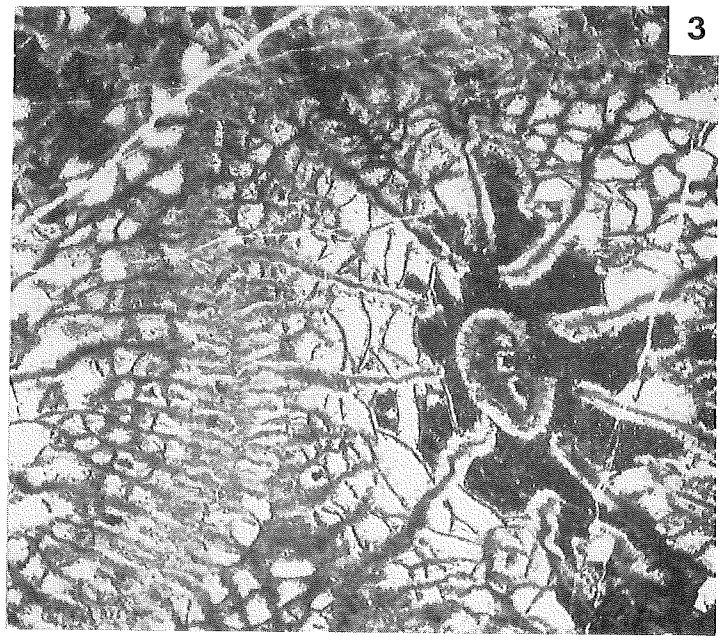
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Explanation of plate 2

Akagophyllum akagoense (OZAWA) ····· P. 74

Fig. 1. Cross section. UHR 18145 a (×6.3)

Fig. 2. Cross section. UHR 18145 a (×7.5). Both belonging to the same corallum.

Fig. 3. Longitudinal section. UHR 18145 b (×5.9)

Fig. 4. Oblique section. III 77, OZAWA collection, Tokyo University. (×5.8)

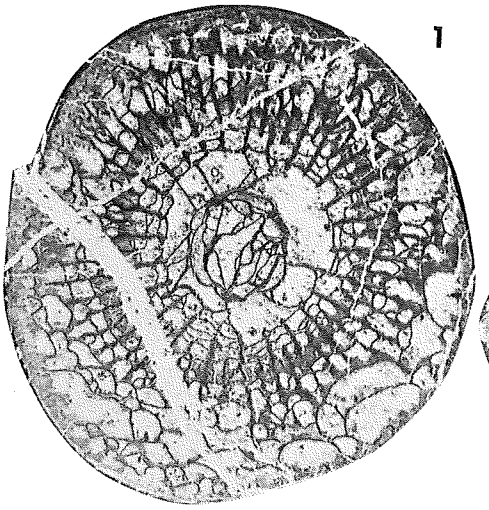
All specimens are from *Pseudofusulina* limestone at Kaerimizu, Akiyoshi-dai, Yamaguchi Prefecture.

Wentzelophyllum felseri, sp. nov. ····· P.204

Fig. 5. Cross section. UHR 17880 b (×3.3)

Fig. 6. Cross section showing the wall structure. UHR 17885 (×13.3)

Pseudoschwagerina zone. Ostwand Halde Hüttenkofel, Carnic Alps.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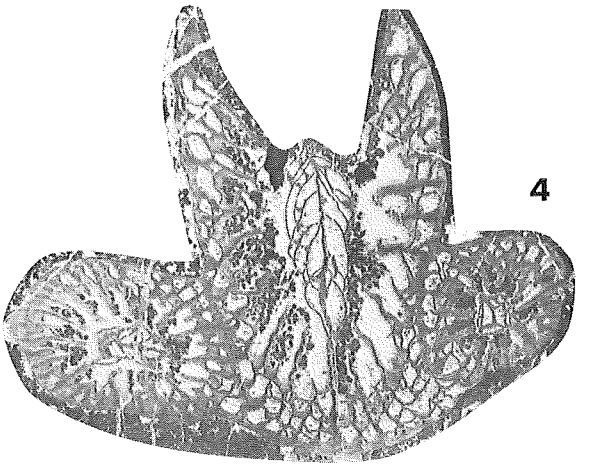
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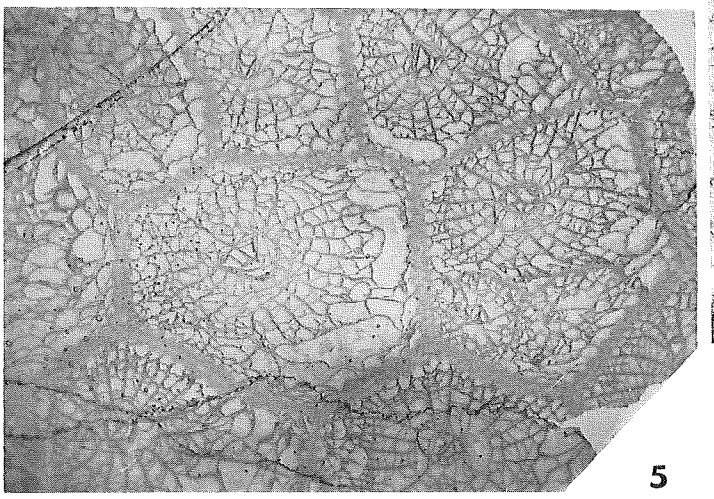
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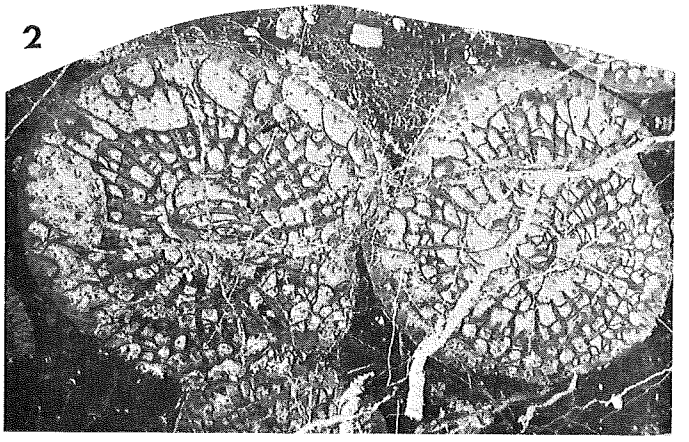
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3

Explanation of plate 3

Akagophyllum hasegawai, sp. nov. ..... P. 80

Fig. 1. Cross section: UHR 18147 a (holotype) *Pseudofusulina?* zone. Behind the Hinaga Shrine, Miné city, Yamaguchi Prefecture. (×6.7)


1

Explanation of plate 4

Waagenophyllum (*Waagenophllum*) *pulchrum* (HAMADA) ····· P.116

Fig. 1 & 2. Cross section. Corallites belonging to the same corallum. UHR 18193 (×13.5)
Yabeina zone. Takagami quarry, Chohshi city, Chiba Prefecture.

Praewentzelella honjoi, gen. et sp. nov. ····· P.181

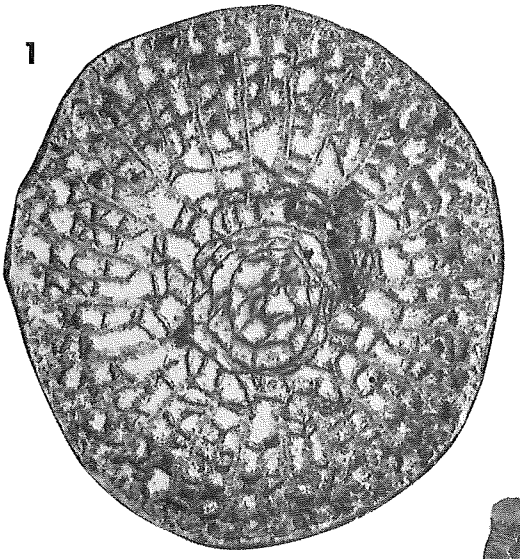
Fig. 3. Cross section. UHR 18204 (holotype) (×5.5)

Fig. 4. Cross section. UHR 18197 (×5.4)
Neoschwagerina zone. Kinsyo-zan, Akasaka, Gifu Prefecture.

Pavastehphyllum (*Sakamotosawanella*) *sakamotosawanum*, nom.nov. ····· P. 66

Fig. 5. Cross section. UHR 15519 (×5.8)

Fig. 6. Cross section. UHR 15527 (holotype) (×6.1)
Pseudoschwagerina to *Pseudofusulina* zone.
Sashizawa, Maiya, Towa-cho, Tome-gun, Miyagi Prefecture.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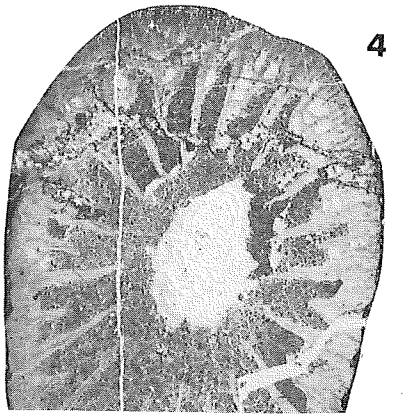
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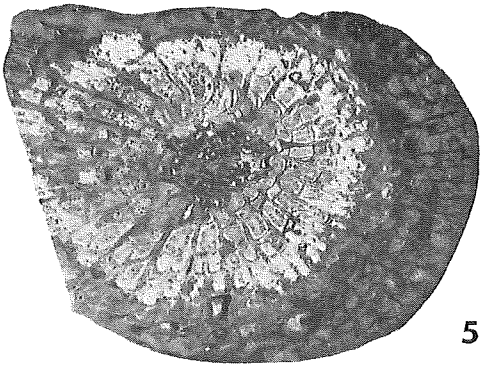
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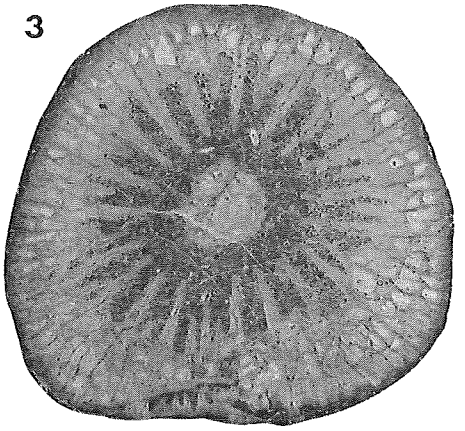
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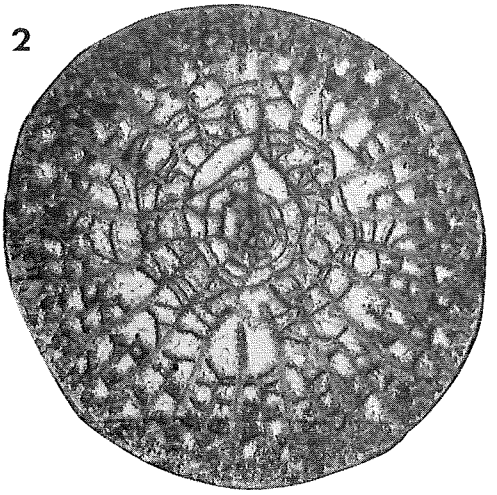
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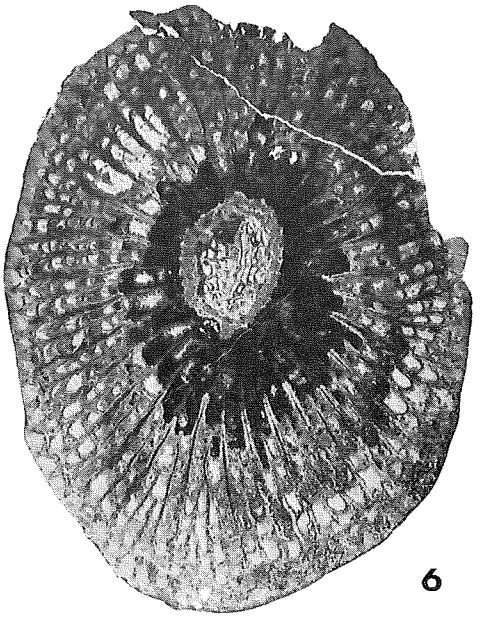
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Explanation of plate 5

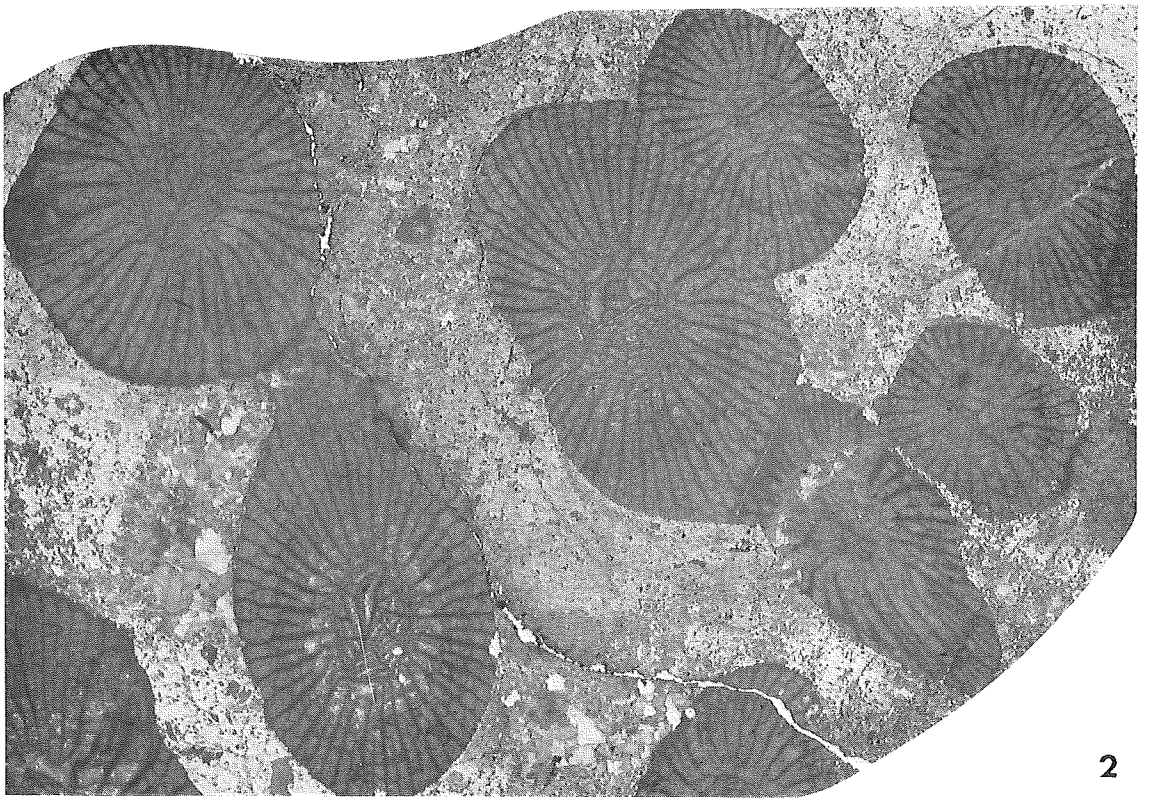
(All figures four times natural size.)

Pseudohuangia stoecklini, sp. nov. ····· P. 94

Fig. 1. Longitudinal and tangential sections. Reg. no. UHR 18301 (A replica of holotype)
Locality: South flank of Kuh-e-Jamal, Southeast of Tabas, East Iran.
Horizon: *Pseudofusulina* to *Parafusulina* zone.

Fig. 2 Obliquely cut cross section. Reg. no. UHR 18302 (A replica of holotype)
Locality and horizon: The same as above.

1



2

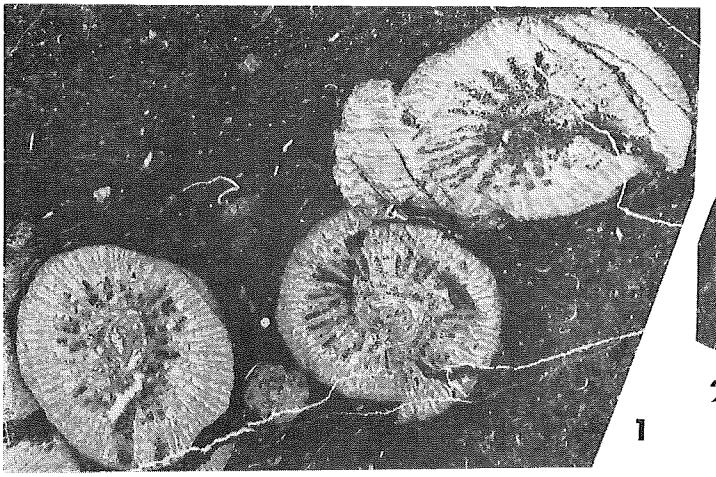
Explanation of plate 6

(All figures four times natural size.)

Waagenophyllum (*Waagenophyllum*) *akasakense* (YABE) P.114

Fig. 1. UHR 18191 b
Fig. 2. UHR 15544
Fig. 3. UHR 16475
Fig. 4. UHR 18189
Fig. 5. UHR 18190
Fig. 6. UHR 15542
Fig. 7. UHR 18191 a
Fig. 8. UHR 15539

All are from the *Yabeina globosa* limestone, Kinsyo-zan, Akasaka, Gifu Prefecture.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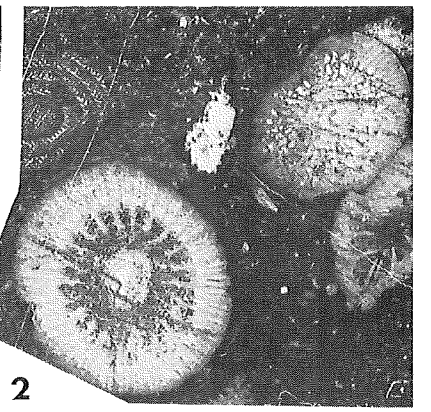
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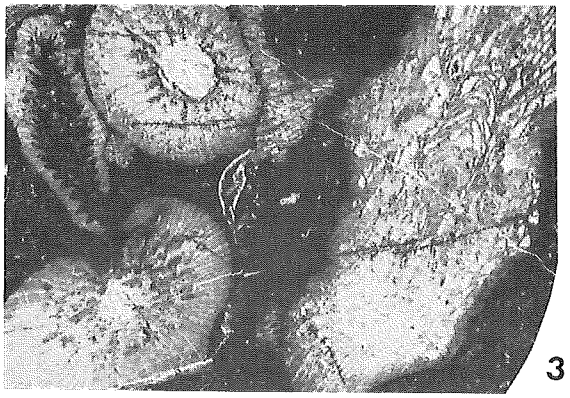
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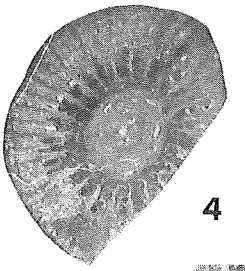
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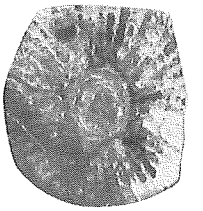
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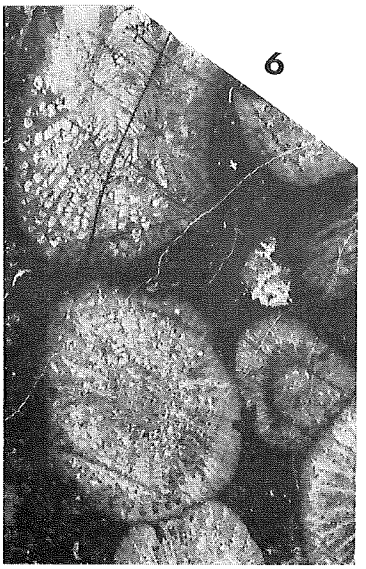
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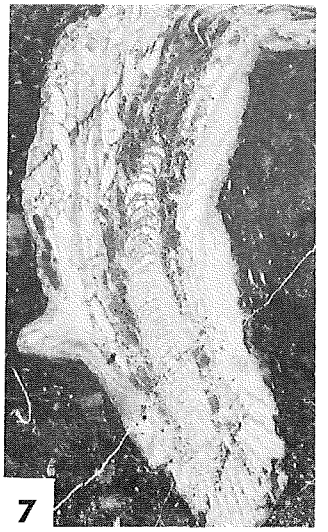
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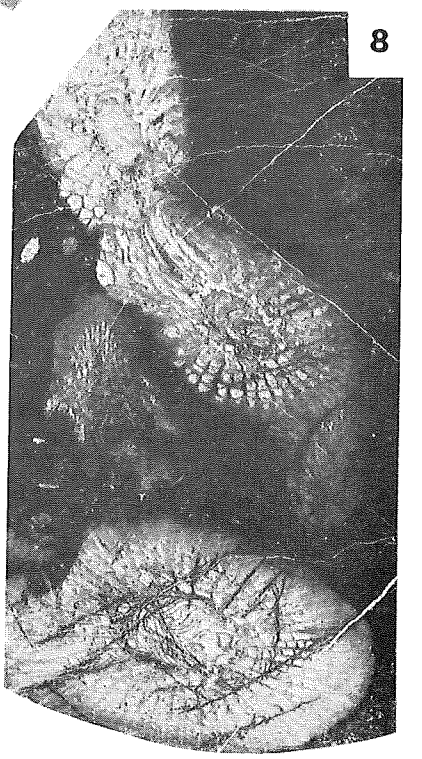

8

Explanation of plate 7

(All figures four times natural size.)

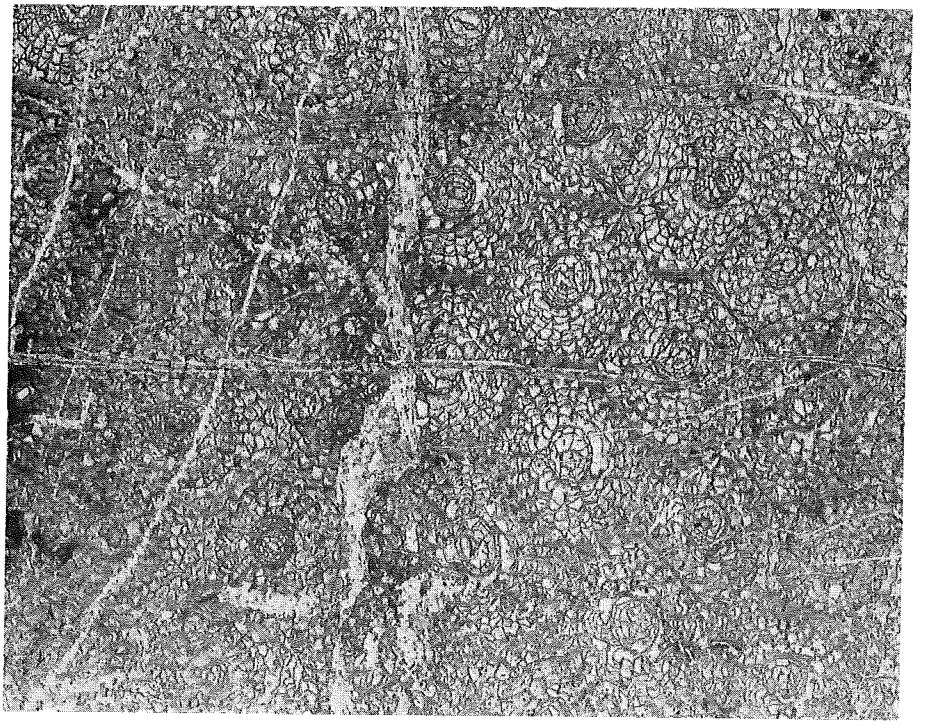
Parawentzelella (*Miyagiella*) *motoyoshiensis*, sp. nov. P.170

Fig. 1. Cross section. UHR 18236 (holotype)

Waagenophyllum (*Waagenophyllum*) *virgalense* (WAAGEN et WENTZEL) P.109

Fig. 2. Cross section. UHR 18212 (large variety).

Both forms were collected from limestone of *Neoschwagerina* zone, Iwaizaki, Kesennuma city, Miyagi Pref.



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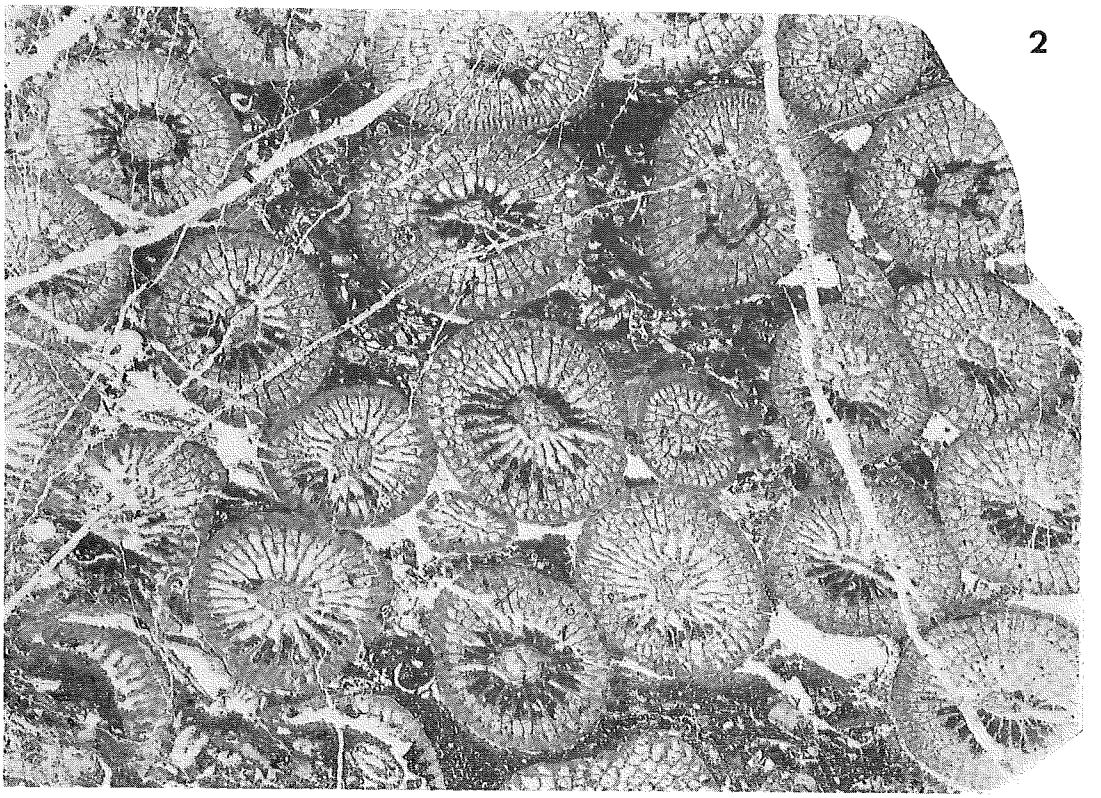


2

Explanation of plate 8

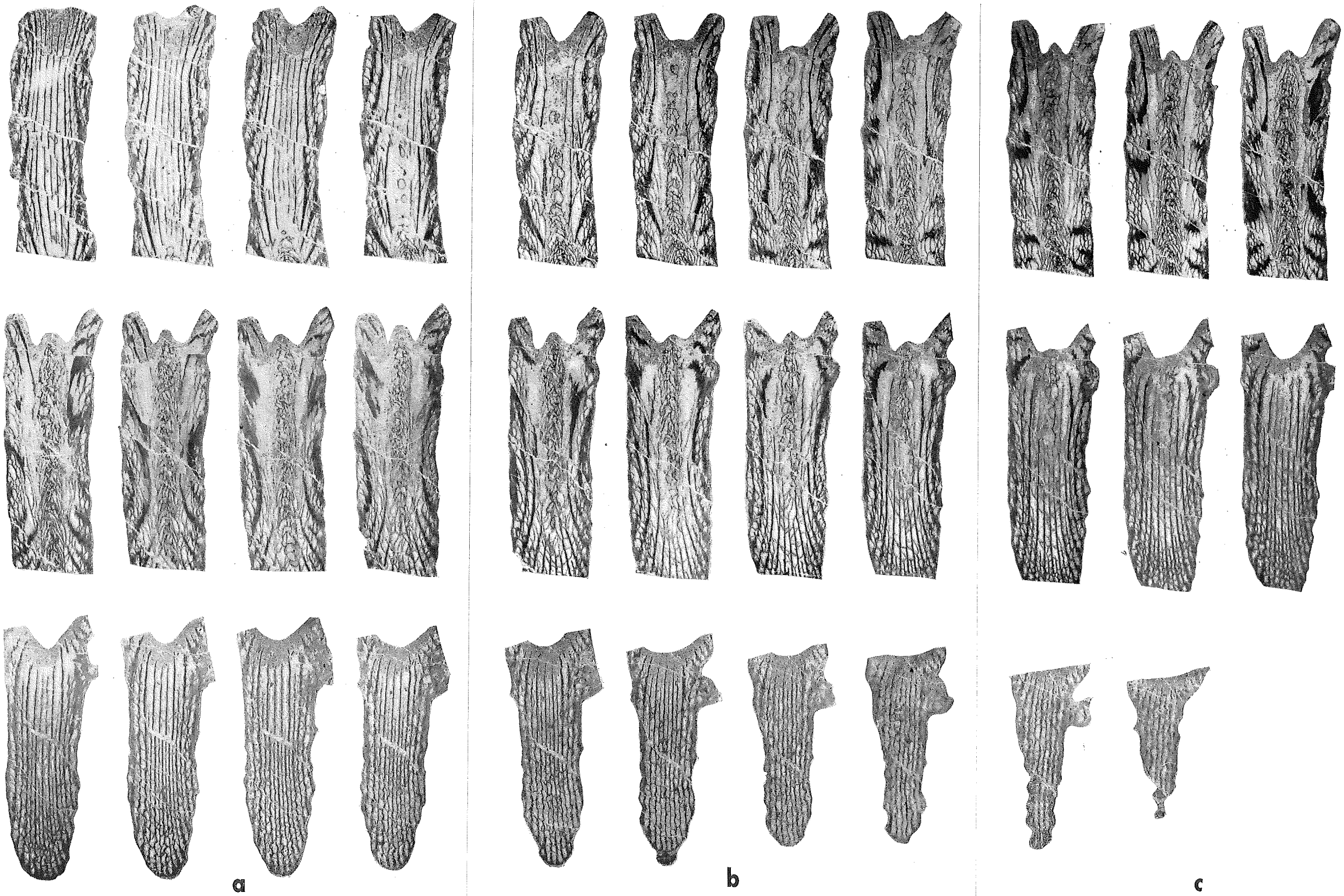
(All figures are five times natural size.)

Waagenophyllum (*Waagenophyllum*) *pulchrum* HAMADA P.116

Photos are showing the replica films taken from the longitudinal polished surface of a single corallite in a series. Each interval of the figures is about 170μ. Specimen was at first polished by grinder and then etched by 5% NH_4Cl at 20°C within 20 minutes. Replicas were taken by the courtesy of Dr. Y. HASEGAWA.

Yabeina zone.

Takagami quarry, Chohshi city, Chiba Prefecture.


a
b
c

Explanation of plate 9

(All figures four times natural size.)

Yokoyamaella (*Yokoyamaella*) *yokoyamai* (OZAWA) P.136

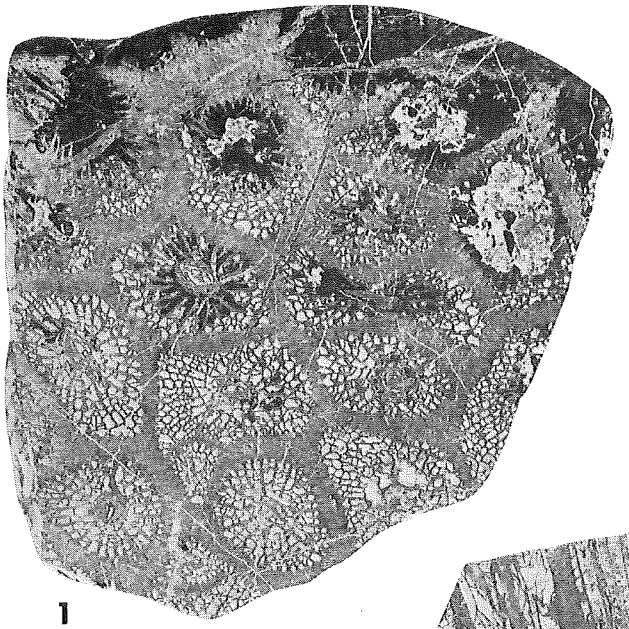
Fig. 1. Cross section. UHR 18148 c

Fig. 2. Longitudinal section. UHR 18148 b

Fig. 3. Cross section. UHR 18148 a

Fig. 4. Longitudinal section. No. III 63, OZAWA collection, Tokyo University.

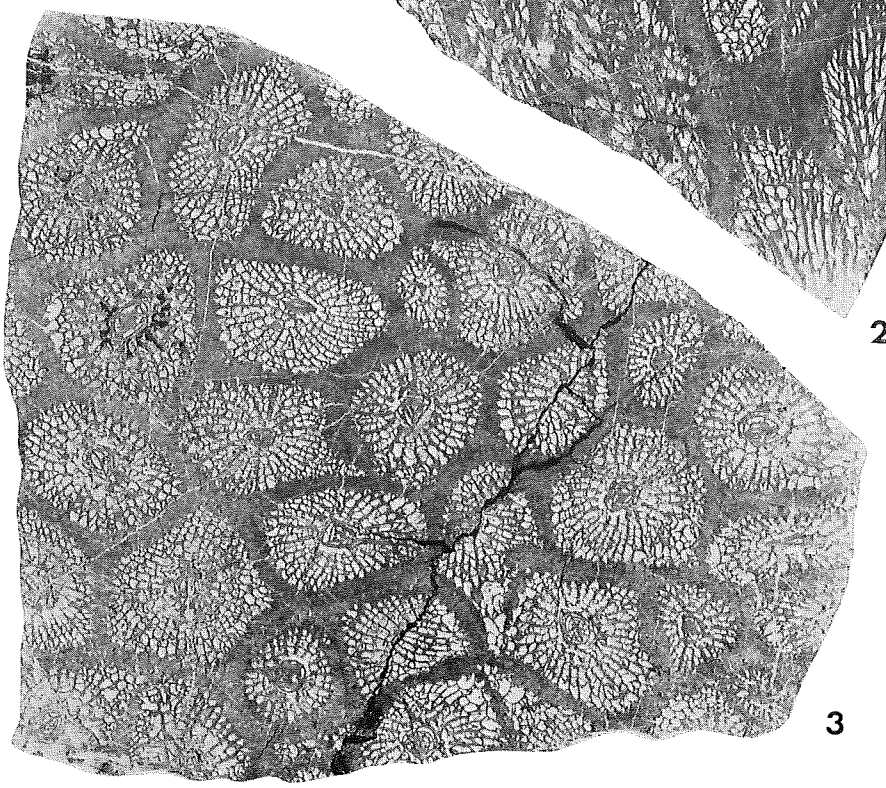
All are from *Pseudofusulina* zone at Kaerimizu, Akiyoshi-dai, Yamaguchi Prefecture.



1

4

2



3

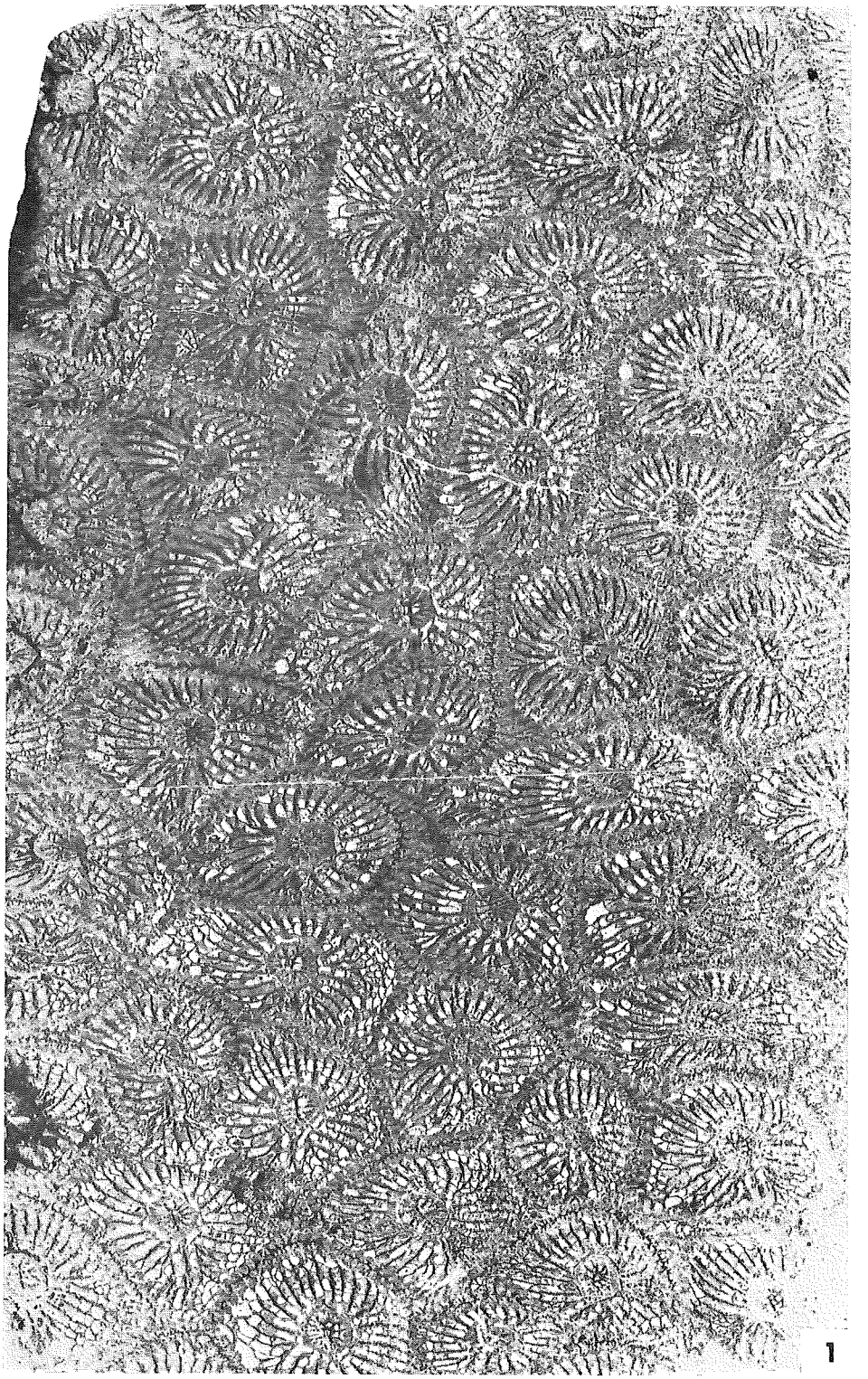
Explanation of plate 10

Yokoyamaella (*Yokoyamaella*) *kurohime*, sp. nov. P.141

Fig. 1. Cross section. UHR 18151 (holotype)

Pseudofusulina zone.

Summit of Mt. Kurohime, Omi-cho, Nishikubiki-gun, Niigata Prefecture. (×4)



1

Explanation of plate 11

(All figures four times natural size.)

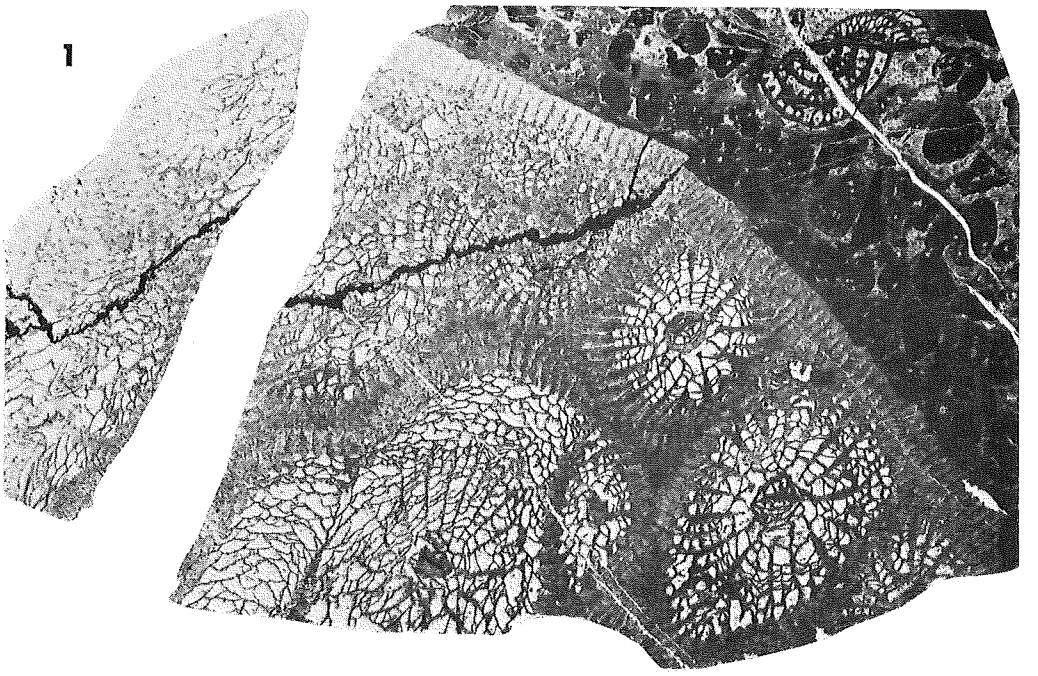
Yokoyamaella (*Yokoyamaella*) *tertioseptata* (YOKOYAMA) P.139

Fig. 1. Cross section. IGSH Y. T. 6 (holotype), Hiroshima University.

Fig. 2. Longitudinal section. IGSH Y. T. 6 (holotype), Hiroshima University.

Pseudofusulina zone.

Misaka, Tojo-cho, Hiba-gun, Hiroshima Prefecture.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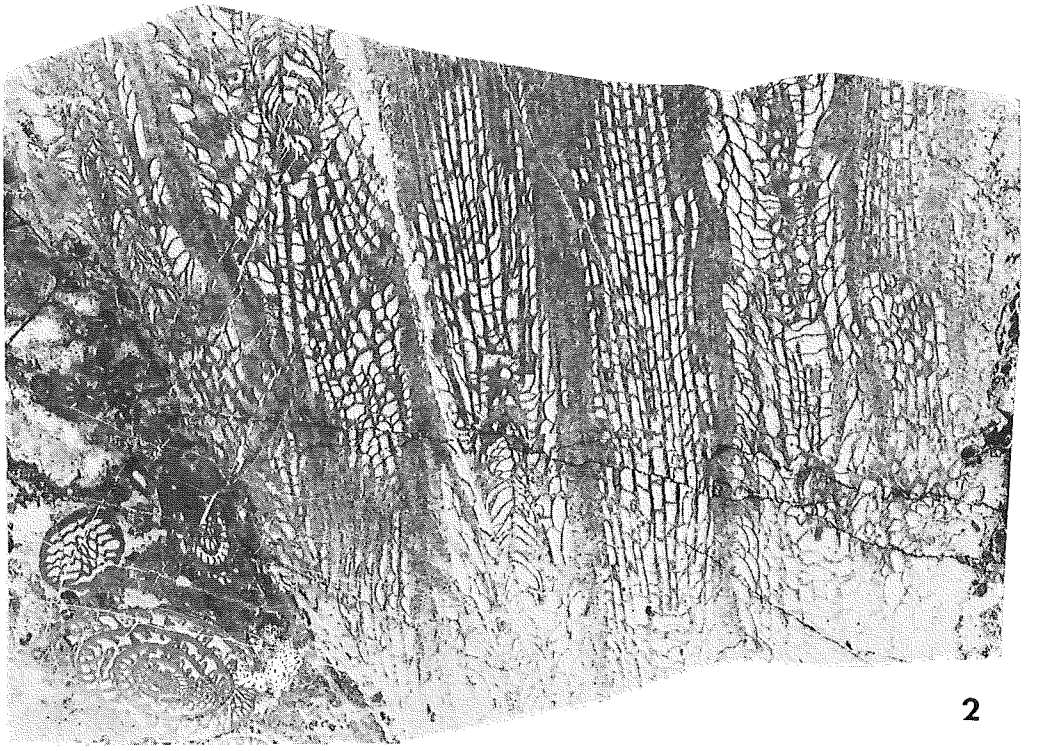

2

Explanation of plate 12

Yokoyamaella (*Maoriphyllum*) *ozawai* (MINATO) P.146

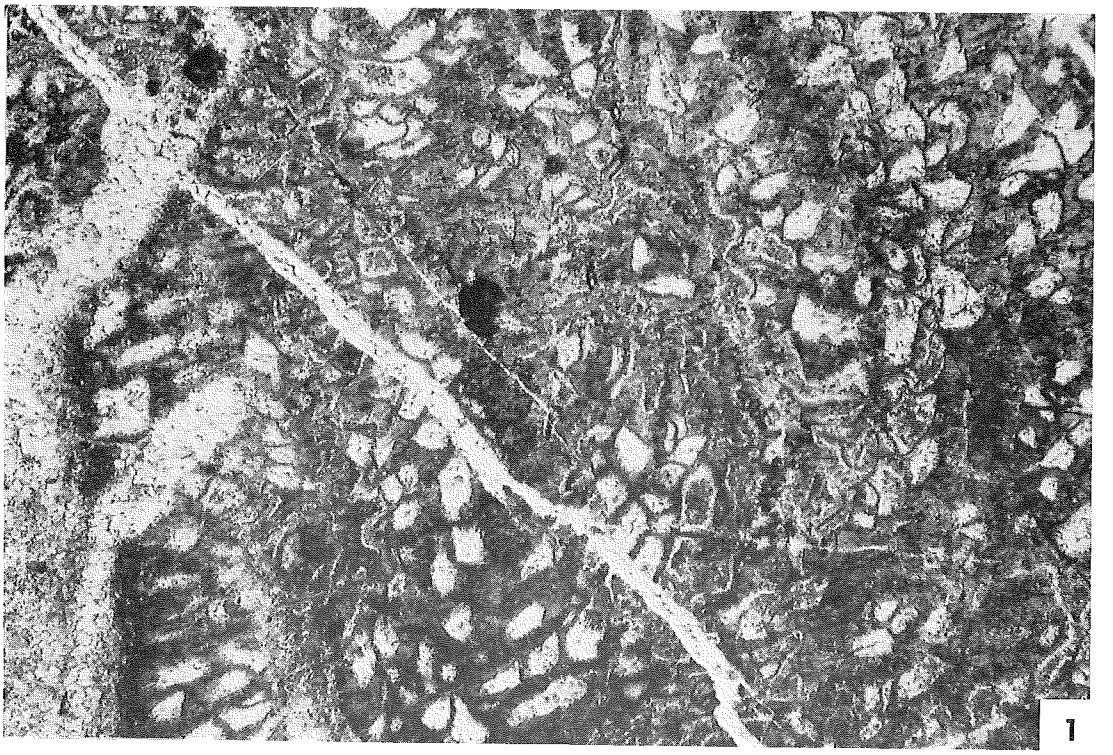
Fig. 1. Cross section. Reg. no. III 54, Inst. of Geol. Tokyo Univ.

Fig. 2. Cross section. Reg. no. III 55, Inst. of Geol. Tokyo Univ.

Locality: Shibukura. Mine city, Yamaguchi Prefecture.

Horizon: *Neoschwagerina* zone.

(All figures ten times natural size.)



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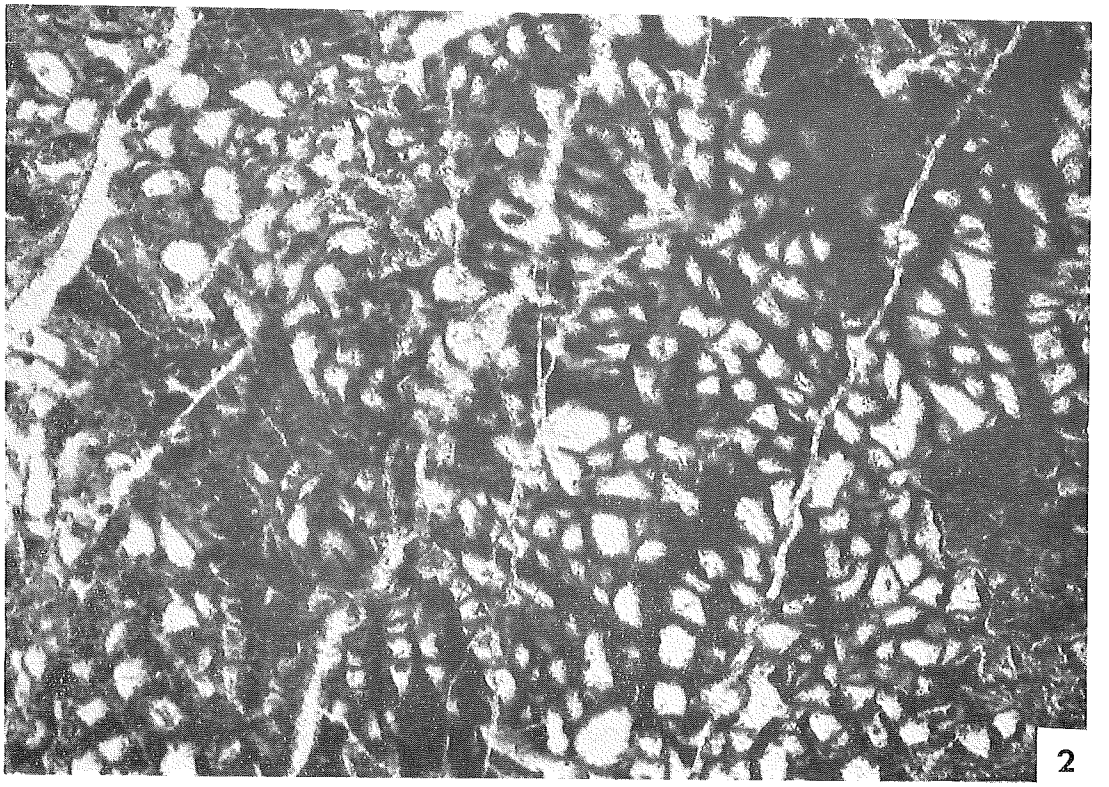


2

Explanation of plate 13

(All figures four times natural size.)

Parawentzelella (Miyagiella) miyagiensis, sp. nov. ····· P.168

Fig. 1. Cross section. UHR 18274 (holotype)

Fig. 2. Cross section. UHR 18273 (holotype)

Fig. 3. Cross section. UHR 18272

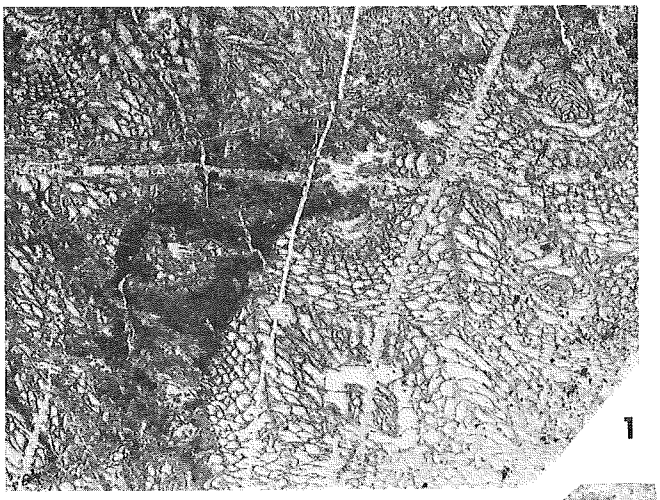
Parawentzelella (Parawentzelella) rugularis FONTAINE ····· P.166

Fig, 4. Oblique section. UHR 18253

Fig. 5. Cross section. UHR 18252

Fig. 6. Longitudinal section. UHR 18247

All are from the limestone of *Neoschwagerina* zone, Iwaizaki, Kesennuma city, Miyagi Prefecture.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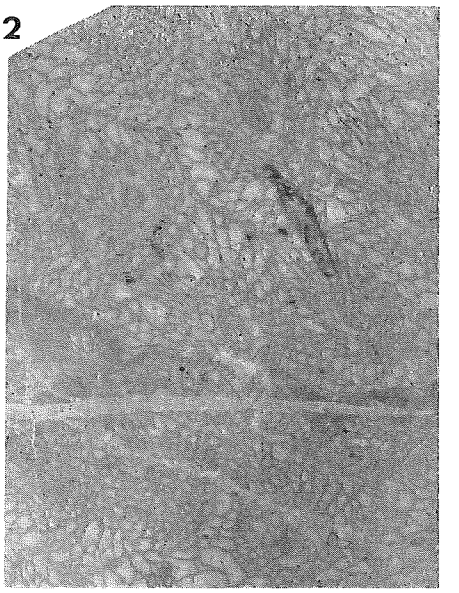
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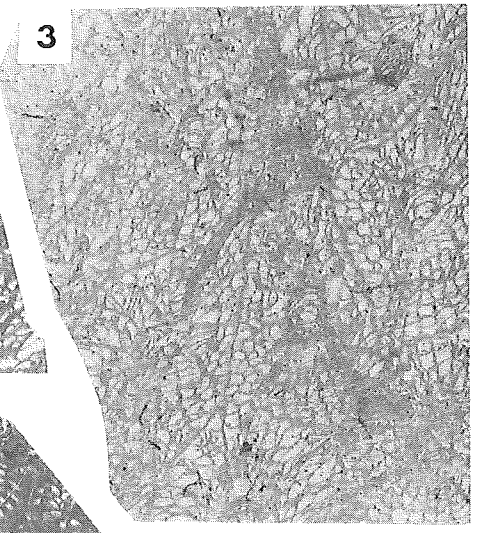
4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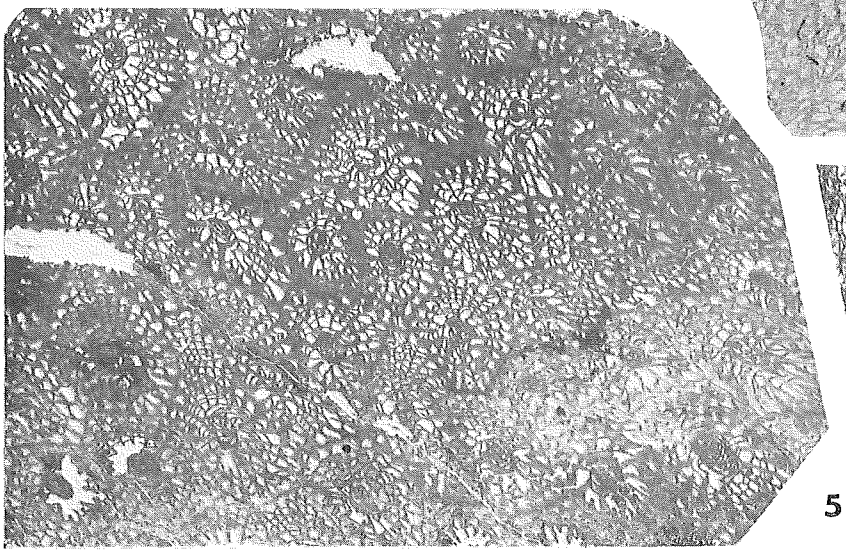
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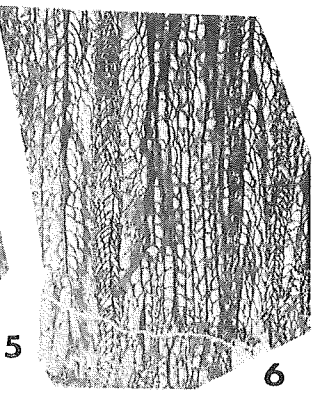

6

Explanation of plate 14

(All figures four times natural size.)

Parawentzelella (Miyagiella) motoyoshiensis, sp. nov. P.170

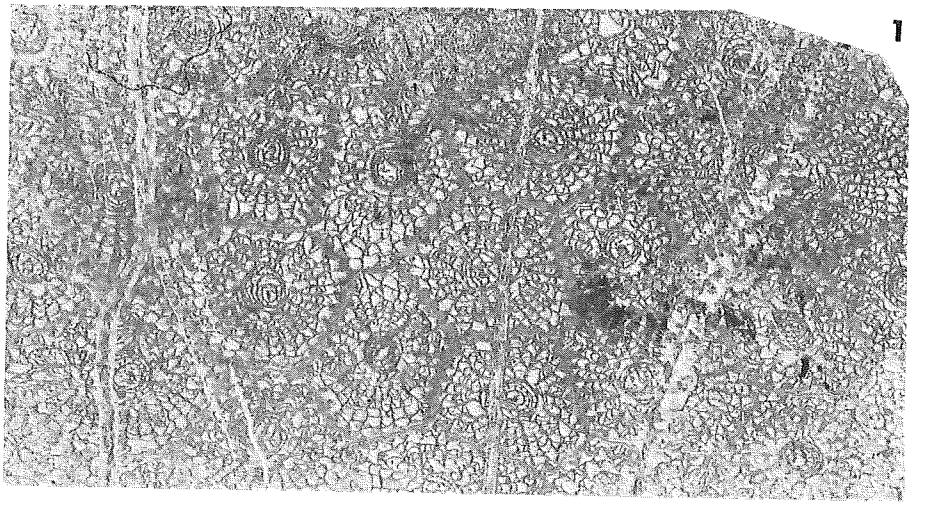
Fig. 1. Cross section. UHR 18234 (holotype)

Fig. 2. Longitudinal section. UHR 18235 (holotype)

Figs. 3–4. Longitudinal section. UHR 18232–3 (holotype)

Fig. 5. Cross section. UHR 18241

All are from the limestone of *Neoschwagerina* zone, Iwaizaki, Kesennuma city, Miyagi Prefecture.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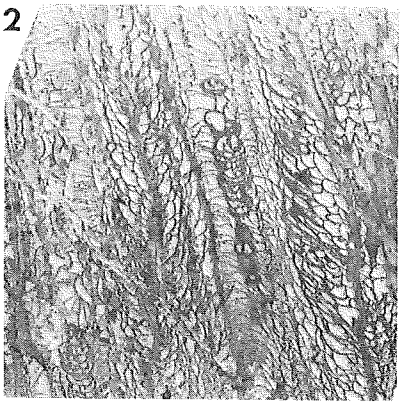
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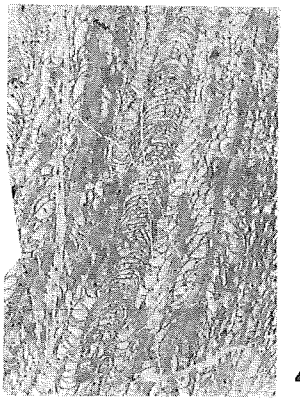
3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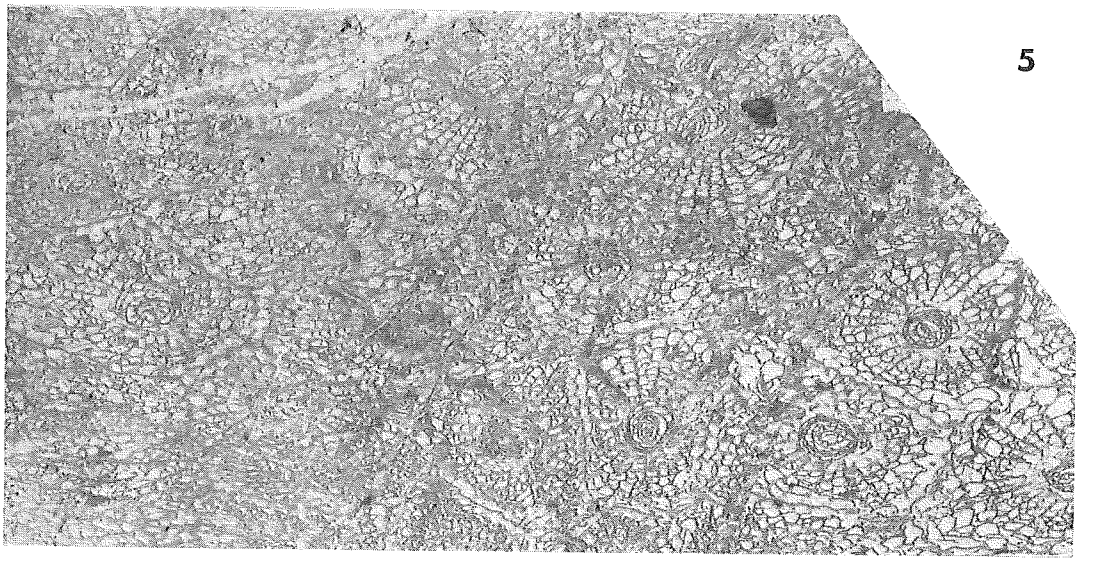

5

Explanation of plate 15

Iranophyllum (*Laophyllum*) *nakamurai*, sp. nov. ····· P.176

Fig. 1a. Cross section. UHR 18255 (×3)

Fig. 1b. Longitudinal section. UHR 18256 (×3)

Fig. 1c. Cross section. UHR 18257 (×4)

Fig. 1d. Cross section. UHR 18258 (×3)

Fig. 1e. Oblique section. UHR 18259 (×3)

Fig. 1f. Cross section. UHR 18260 (×3)

Serial sections from the holotype.

Pseudoschwagerina zone.

Iwahata-sawa, Yukisawa, Rikuzen-takada city, Iwate Prefecture.

Iranophyllum (*Iranophyllum*) *tunicatum* IGO ····· P.174

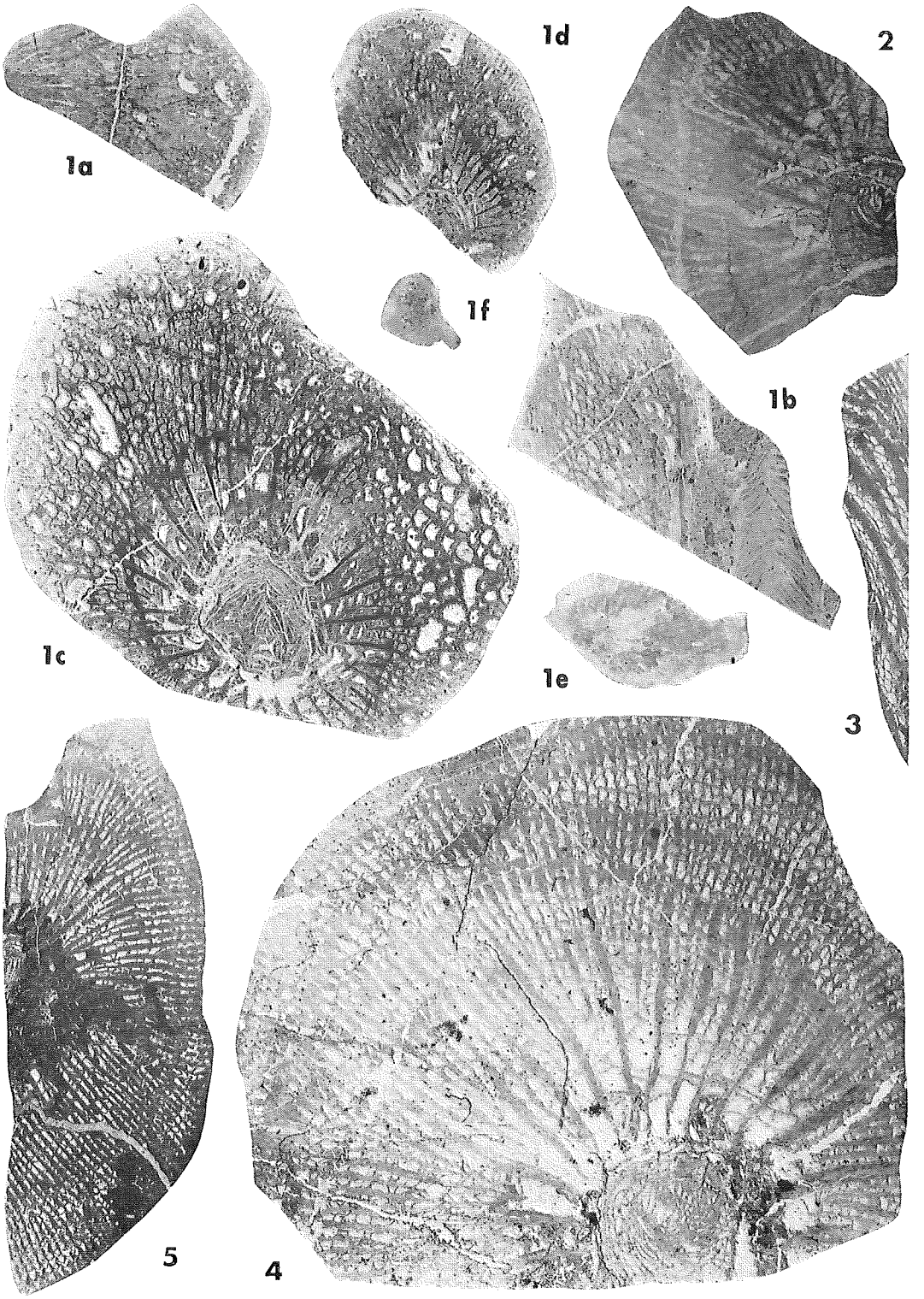
Fig. 2. Cross section. UHR 18266 (×3)

Fig. 3. Oblique section of dissepimentarium. UHR 18269 (×3)

Fig. 4. Cross section. UHR 18265 (×4)

Fig. 5. Cross section. UHR 18268 (×3)

All are from the limestone of *Neoschwagerina* zone, Iwaizaki, Kesennuma city, Miyagi Prefecture.


1a
1d
2
1f
1b
1c
1e
3
5
4

Explanation of plate 16

(All figures four times natural size.)

Praewentzella honjoi, sp. nov. P.181

Fig. 1. Cross section. UHR. 18205

Fig. 2. Oblique section. UHR 18199

Fig. 3. Oblique section. UHR 18203

Fig. 4. Cross section. UHR 18196

Fig. 5. Oblique section. UHR 18198

Neoschwagerina zone. Kinsyo-zan, Akrasaka, Gifu Prefecture.

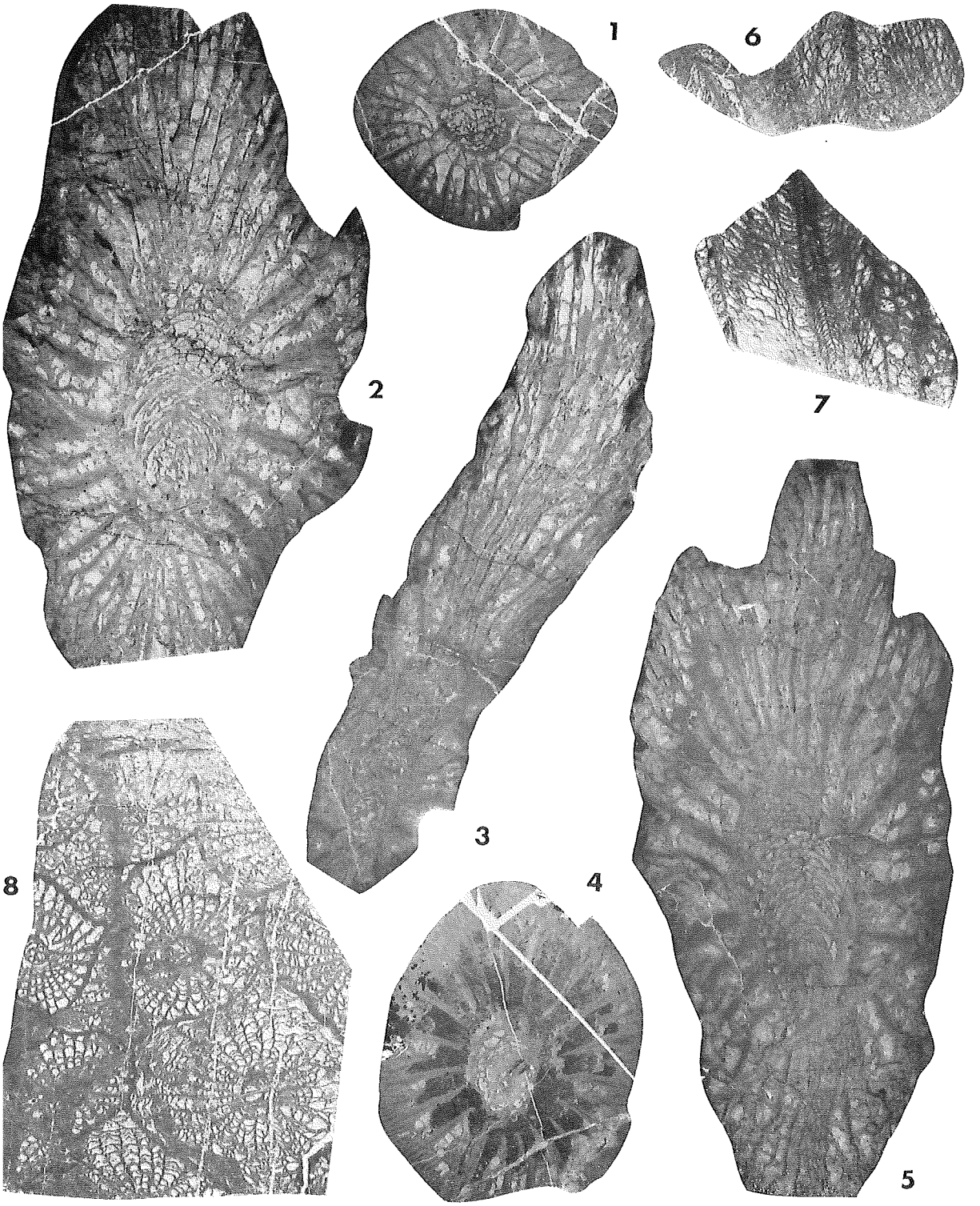
Ipciphyllum laosense (PATTE) P.149

Fig. 6. Longitudinal section. UHR 18171

Fig. 7. Longitudinal section. UHR 18173

Fig. 8. Cross section. UHR 18174

Yabeina zone? or *Parafusulina?* zone. Shigeyasu, Minê city, Yamaguchi Prefecture.


1
2
3
4
5
6
7
8

Explanation of plate 17

(All figures four times natural size.)

Wentzelella (Szechuanophyllum) kitakamiensis YABE et MINATO P.190

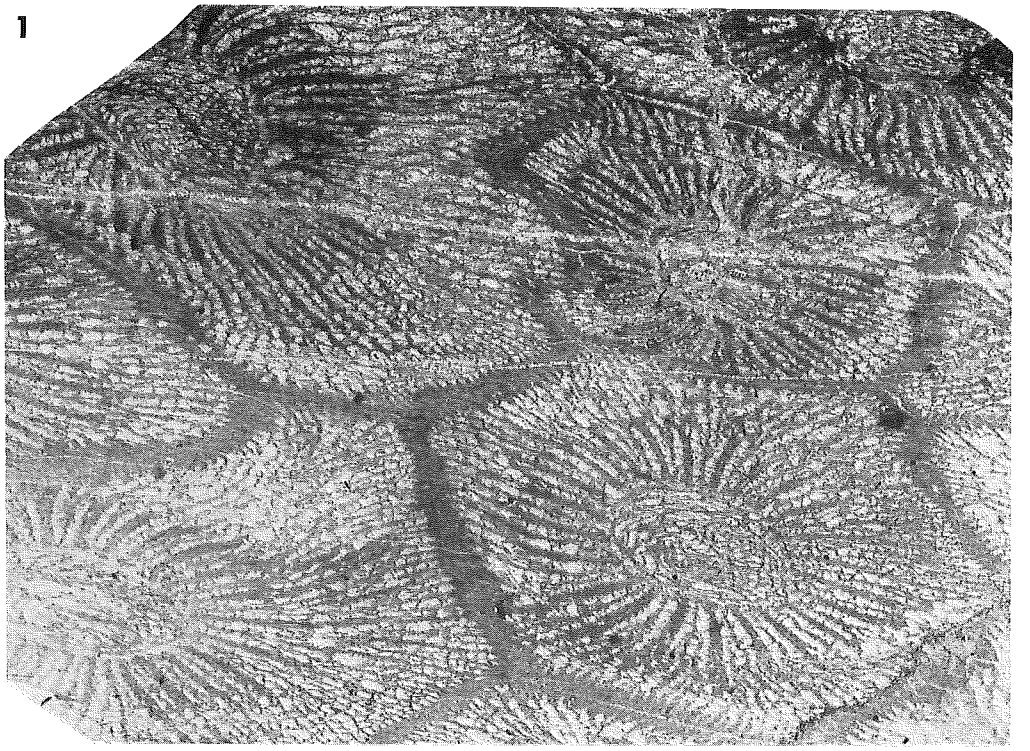
Fig. 1. Cross section. UHR 15157 (Syntype)

Fig. 2. Oblique section. UHR 15159

Locality: Kattisawa, Sumita-cho, Kesen-gun, Iwate Prefecture.

Horizon: *Neoschwagerina* zone, Kanokura series.

1



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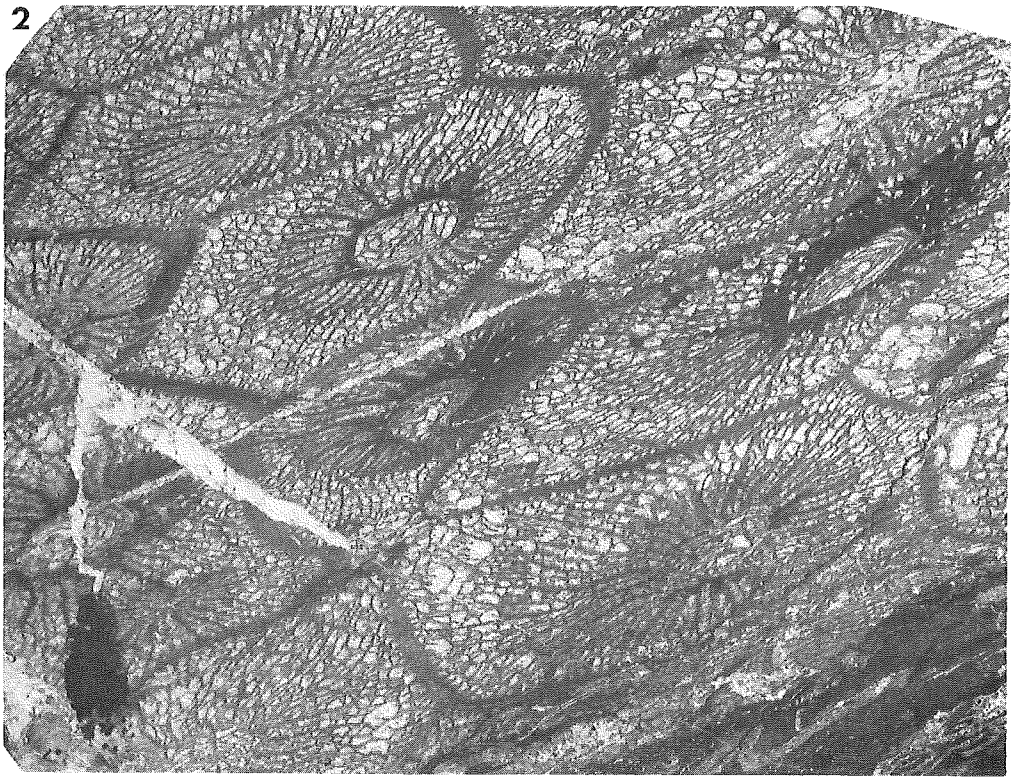


Explanation of plate 18

Wentzelophyllum eguchii (YOKOYAMA) ····· P.207

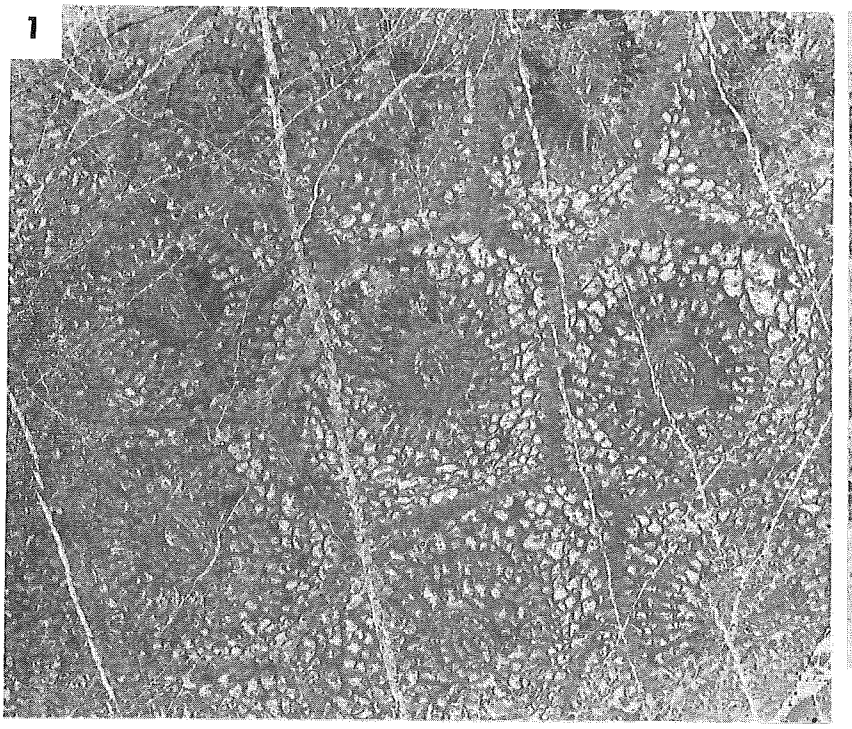
Fig. 1. Cross section (×4) Reg. no. IGSH Y. T. no. 5 (holotype)
Locality: Misaka, Tojo-cho, Hiba-gun, Hiroshima Prefecture.
Horizon: *Pseudoschwagerina* to *Pseudofusulina* zone

Wentzelella (*Wentzelella*) *osobudaniensis* IGO ····· P.188

Fig. 2. Cross section (×4) Reg. no. JPC. 40001 (holotype)
Locality: Nabae, Takahama city, Fukui Prefecture.
Horizon: Permian

Wentzelophyllum felseri, sp. nov. ····· P.204

Fig. 3. Cross section (×9) UHR. 17885
Locality: Ostwand Halde, Hüttenkofel, Carnic Alps.
Horizon: *Pseudoschwagerina* zone.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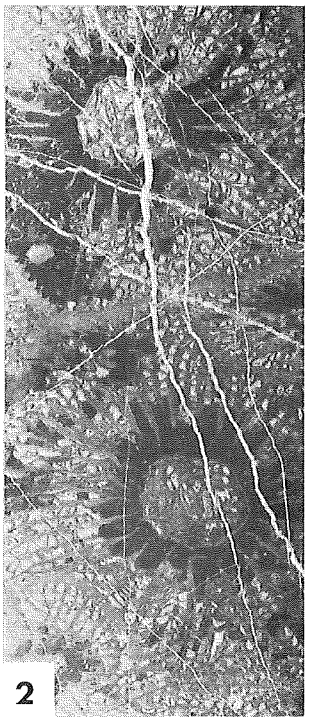
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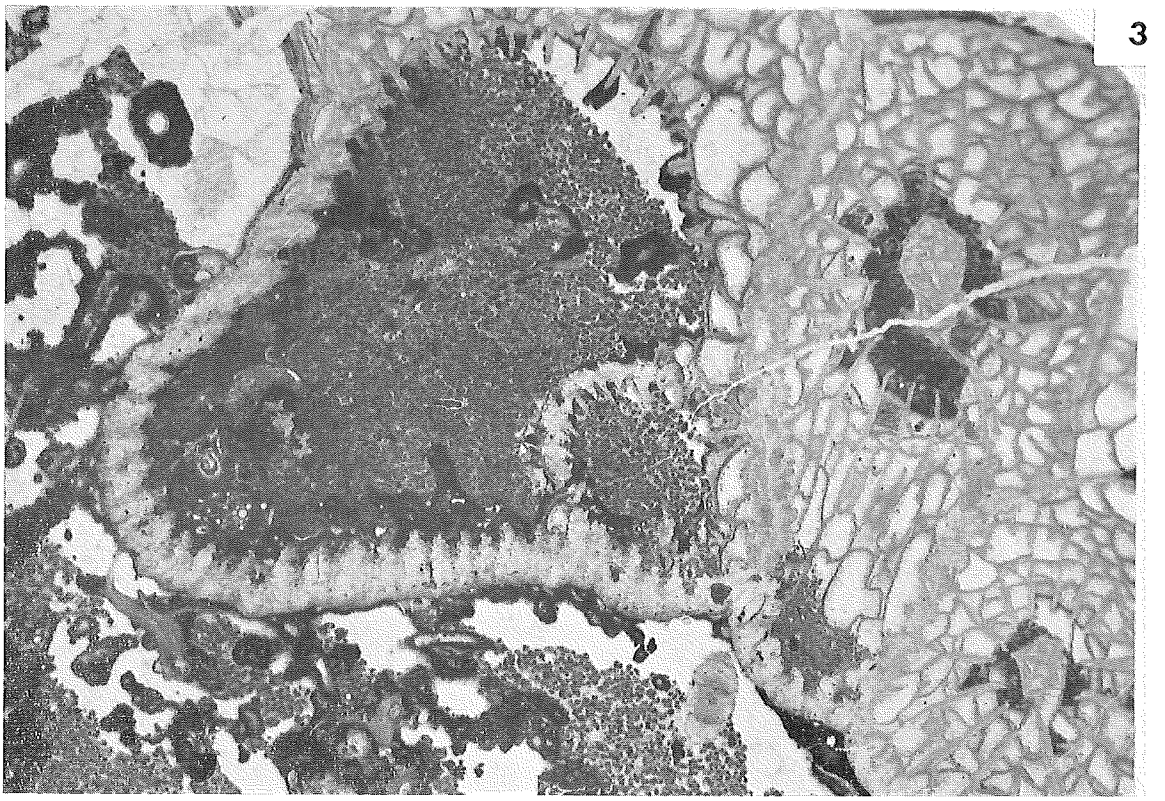

3

Explanation of plate 19

(All figures four times natural size.)

Wentzelophyllum hayasakai, sp. nov. ····· P.207

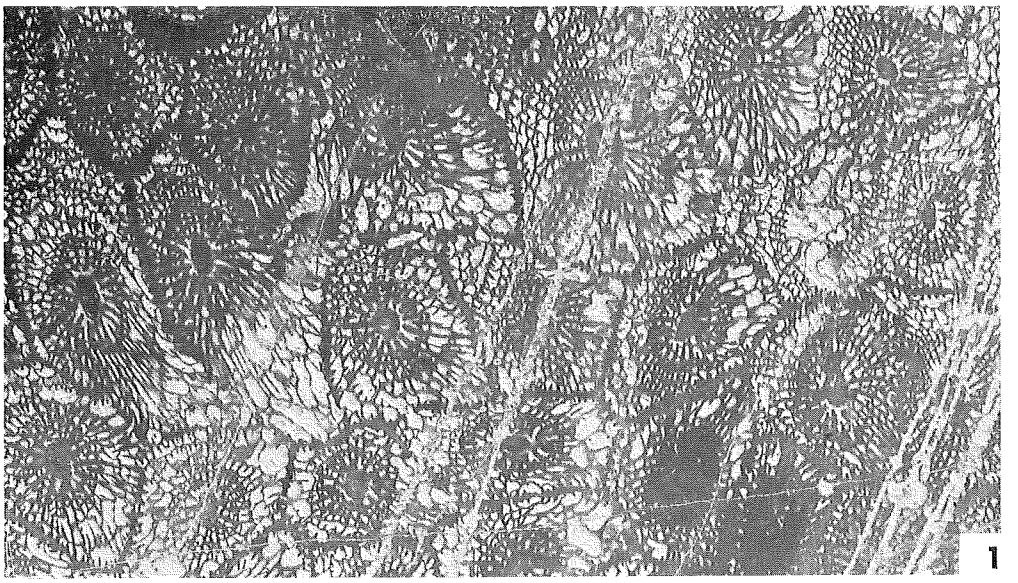
Fig. 1. Cross section. UHR 18283

Fig. 2. Obliquely cut longitudinal section. UHR 18284

Fig. 3. Obliquely cut longitudinal section. UHR 18281

Locality: Sekiya, Hikoroichi, Ofunato city, Iwate Pref.

Horizon: *Pseudofusulina* zone.



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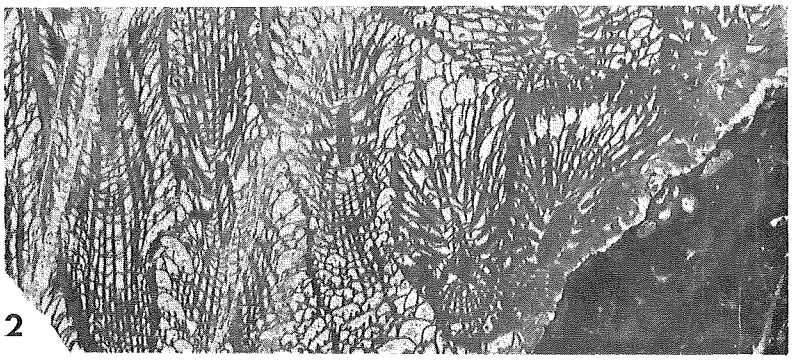

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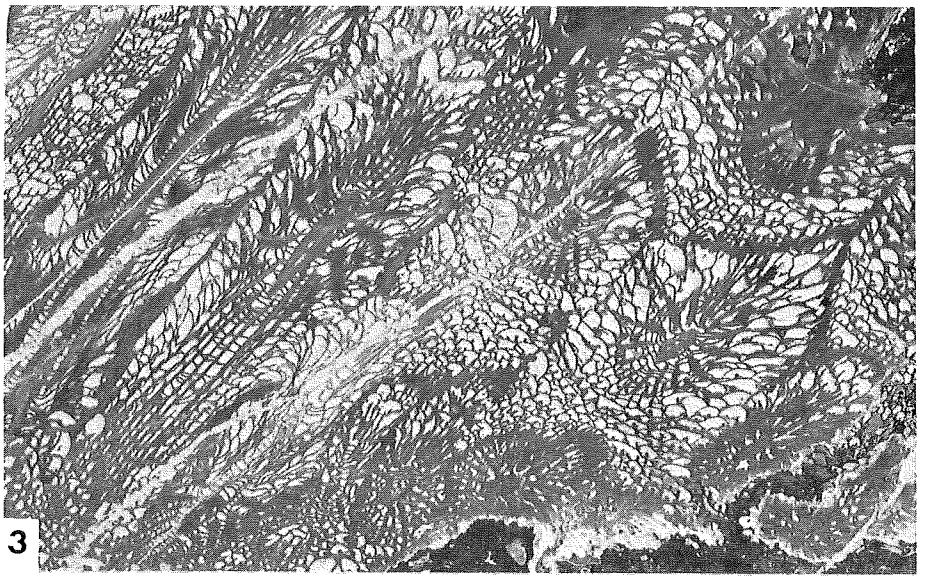


3

Explanation of plate 20

(All figures four times natural size.)

Wentzelophyllum? tabasense, sp. nov. P.213

Fig. 1. Cross section. UHR 18296

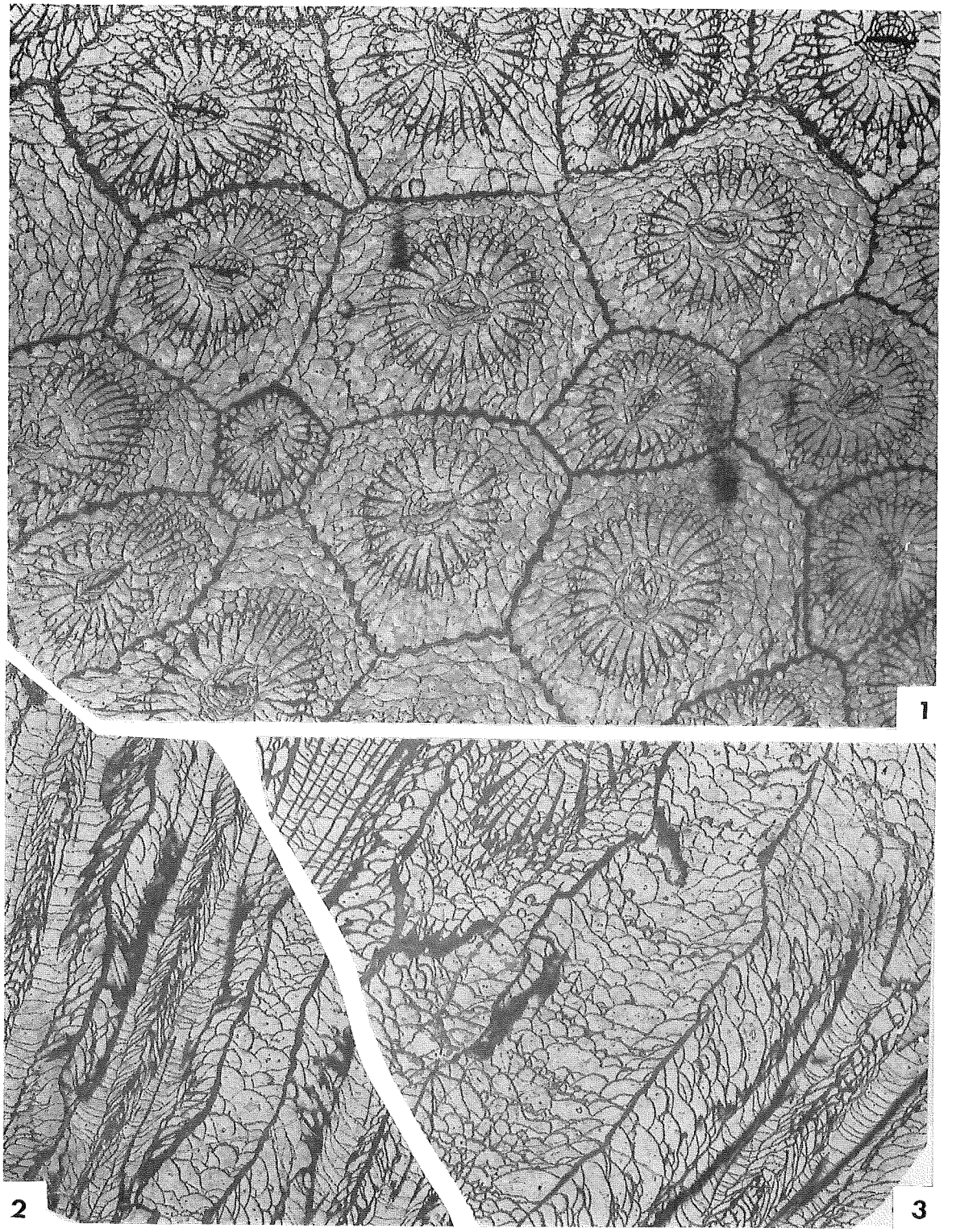
Fig. 2. Longitudinal Section. UHR 18287

Fig. 3. Longitudinal Section. UHR 18297

All are replicas taken from the holotype, UHR 18152

Locality: Southeast of Tabas, East Iran.

Horizon: *"Parafusulina"* zone


1
2
3