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第一冊

中國北部奧陶紀動物化石

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中國北部奧陶紀之動物化石(節譯)

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中國北部奧陶紀之化石種類甚多，從前曾經鑒定者僅左列四種。

(1) *Actinoceras richthofeni* Frech

(1) *Maclurea logani* Salter

(1) *Plectambonites sericeus* (Sowerby)

(四) *Asaphus boehmi* Lorenz

前一種係滿洲所產，後三種發見於山東。此次鑒定結果，新增化石四十一種。(四十種爲新種)

中國北部奧陶紀之化石，現已有五十八種之多，(共三十一屬)分佈于下列各系。

(一) 北林子系(下奧陶紀)七種

(二) 亮家山系(下奧陶紀)四種(其中一種與北林子系所產者同)

(三) 冶里石灰岩(中奧陶紀)二種

(四) 馬家溝石灰岩(上奧陶紀)四十六種

以上各層系，維理士總稱之爲濟南石灰岩，李希霍雲誤認爲煤紀灰岩。Kohlenkalk 化石因層系互異，茲分論之如左。

(一) 北林子系

是系爲石灰岩所組成，厚約九十五公尺，分佈於直隸東北臨榆縣石門寨一帶，其時代爲下奧陶紀。岩層自三

十三公尺以下、有一薄層產化石極富、古盃珊瑚 *Archeocyathus* 及頭足類等爲此系標準化石。

古盃珊瑚 *Archeocyathus* 形類海綿、其內部之組織（如隔壁床板等）足以確定其爲珊瑚、爲寒武紀最常見之化石、然在奧陶紀岩層中極不多見。今于此系岩層中採得一種、北美雖曾發見一次、然在中國實爲最初之發現。其產地爲直隸、故定名爲直隸古盃珊瑚。 *Archeocyathus chihliensis*

頭足類化石之最著者爲 *Protocameroceras* 屬、其殼之前端露出極長之體管、此種現象可用以解釋古代頭足類發育之原理、其學名爲 *Protocameroceras mathieu*。直隸角石 *Chilioceras* 屬直隸角石新科 *Chilioceratidae* 爲本系主要化石、此類化石爲 *Chilioceras nathani* 及 *Chilioceras chingwangtaoense* 兩種。（見第二四五版各圖）此外腹足類之 *Ophileta* 亦爲常見之化石。是系與北美 *Boekmantown* 系相當、其時代當屬下奧陶紀。

（一）亮家山系

岩層爲灰色石灰岩、厚二百七十五公尺、下部爲厚約一百五十五公尺之石門寨頁岩及石灰岩（無化石）與亮家山系成不整一層。是系自五十三公尺以下有一薄層、產頭足類及腹足類兩類化石、頭足類有 *Camero-ceras* 及 *Piloceras* 兩屬、與北美下奧陶紀上部所產者極相似。是系與上部石炭紀岩層呈不整合之觀。

（二）冶里石灰岩

馬家溝北冶里村附近之石灰岩、名爲冶里石灰岩、是系底部有礫岩、*Basal conglomerate* 位於寒武紀岩層

之上、此種石灰岩產 *Stenoceras* 化石兩種、其時代似屬中奧陶紀。是系與下奧陶紀岩層及上部馬家溝石灰岩之關係、尙難確定。

(四) 馬家溝石灰岩

馬家溝產珠角石 *Actinoceras* 甚富、曾名之爲珠角石石灰岩。*Actinoceras* limestone 於此石灰岩中、共採得化石四十六種、(已經鑒定者僅有三十四種)茲分列之如左。

腕足類

六種

葉鰓類

一種

腹足類

十九種

錐石類

一種

頭足類

十六種

三葉虫

三種

產此類化石之岩層、與北美 Black River and Trenton 層系(上奧陶紀下部)相當、然究與中國南部之奧陶紀異也。

中國古生物誌

ORDOVICIAN FOSSILS FROM NORTH CHINA.

BY

A. W. GRABAU.

INTRODUCTION.

In his classical work on China, Ferdinand von Richthofen classified the great limestone formations which underlie the coal-bearing series of north China as "Kohlenkalk" and referred them to the Carboniferous Limestone of Europe. In this he was not altogether wrong, for we now recognize the existence of Lower Carboniferous (Dinantian) limestones in north China, which carry many elements of the Carboniferous Limestone fauna of western Europe.

The greater part of the limestone series here under consideration was expressly excluded by v. Richthofen from his Sinian System which comprised the Cambrian and older rocks. It and a part of the rocks included in the Sinian are now known to be of Ordovician age, as was indeed recognized by Frech, who in the fifth volume of v. Richthofen's monumental work, published in 1911, described two specimens of *Actinoceras*, (*A. richthofeni* Frech) collected by von Richthofen in Manchuria, and correctly referred them to the Upper Ordovician. Frech further recognized that this form was similar to, or even identical with, a species of *Actinoceras* from Canada which was figured by Barande under the name *Actinoceras richardsoni* Stokes. Frech also described a fragmentary gastropod collected by von Richthofen in the same strata, and referred it tentatively to *Raphistoma æquilaterum* Koken which occurs in the Chasmops-Kalk (Upper Ordovician) of western Europe. He also notes the occurrence of specimens of *Actinoceras* sp. and *Trochoceras* sp. from Shantung, in the British Museum, together with *Dalmanella* cf. *testudinaria* (p. 8).

Previous to the appearance of Frech's monograph, G. C. Crick (1903) had described and figured several specimens of *Actinoceras* obtained by the Rev. Samuel

原书缺页

原书缺页

Couling from the neighborhood of Tsingchou-Fu, Kiaochow, Shantung. Crick however did not identify his specimens specifically, referring to one as closely allied to *Actinoceras* (*Ormoceras*) *tenuifilum* Hall from the Black River formation of New York, and to another as possibly representing the genus *Gonioceras*, a reference which now appears to be probably correct. Besides the cephalopods, Crick mentioned the occurrence of several small brachiopods. According to Buckman "the general appearance suggests *Orthis* (*Dalmanella*) *testudinaria* Dalman, an Ordovician species" *). This is the first published demonstration of the Ordovician age of these limestone in north China. In 1906 Th. Lorenz ** described the following species from the Ordovician of Shantung the first three from Ho-shan the fourth from Santefan.

- | | |
|-----------------------------------|--|
| 1. <i>Asaphus bæhmi</i> Lorenz. | 3. <i>Hyolithes</i> sp. |
| 2. <i>Maclurea logani</i> Salter. | 4. <i>Plectambonites sericeus</i> (Sowerby). |

Frech (in Richthofen V p. 14) referred the first three of these to the Middle Ordovician the fourth to the Upper Ordovician.

In their investigations of the geology of parts of northern China which appeared before Frech's monograph, Bailey Willis and Elliott Blackwelder (in 1903-1904) recognized that the greater part of von Richthofen's Kohlenkalk was to be referred to the Ordovician. Professor Stuart Weller, of the University of Chicago, who studied the fossils collected by Blackwelder, recognized the existence of the cephalopod genus *Orthoceras*, the gastropods *Maclurea*? or *Helicotoma*? and *Lophospira*, the trilobite *Asaphus*?, and the brachiopods *Strophomena* and *Orthis* (*Dalmanella*?) in the Ordovician rocks of Shantung but he was unable to make specific determinations because of the poor state of preservation of the fossils. He however described a number of species collected by Blackwelder in the Yangtze region (south China) *** and recognized their affinities with European Middle Ordovician species. Previously, several authors had described Ordovician fossils from south China among them S. P. Woodward (1856) Kingsmill (1869) and Grieve (1887). The first described the well-known "Pagoda stone" as *Orthoceras* sp. and this was later redescribed by Foord as *Orthoceras chinense* Foord (1888). Kayser and Frech also described a number of Ordovician species from southern China, (v. Richthofen Vols. IV and V) and a number of these have since been redescribed with others by H. Yabe and I. Hayasaka in their work "Palaeontology of South China" (1920). Several Ordovician species from south China were also described and recorded

*) Crick loc. cit p. 483.

**) Beiträge zur Geologie und Palaeontologie von Ostasien, pt II pp 84-90 pl VI.

***) For stratigraphic studies the Yangtzekiang forms the approximate dividing line between North and South China.

by Martelli (1901) Mansuy (1902) Brown (1913) and G. Pellizzari (1913).

In all these studies however, only one new species was recognized in addition to the *Actinoceras* from the Ordovician of north China, namely *Asaphus bæhmi* Lorenz from Shantung, though a number of generic determinations were made and a few forms identified with European species. *Actinoceras richthofeni* has remained up to the present the only specifically identified cephalopod known from the Ordovician of north China, but this species was definitely known only from Manchuria.

During the progress of investigations carried on by the Geological Survey of China, a considerable number of specimens of *Actinoceras* was obtained from the provinces of Chihli and Shantung. Material was also sent to the Survey by residents in various districts. Only a few other fossils were however obtained. Early in the present year some additional species were obtained from Tangshan in the Kaiping coal basin by Messrs. Fred. K. Morris, Geo. B. Barbour and A. C. Terrill, and later, a survey expedition, in charge of the author, began a systematic study of the stratigraphy of certain parts of the Kaiping basin. The party included Professor George B. Barbour of Yenching college (Peking Christian University) and Messrs. Y. C. Sun and S. C. Chean of the Survey. In the field we were joined by Dr. F. F. Matthieu, Geologist of the Kailan Mining Administration and Mr. Jacques Gerard engineer and geologist of the Chaokouchuang mines and later by Mr. C. H. Huang of the Machiakou mining staff *). The greater part of the fossils from the upper beds herein described was collected at that time.

The discovery of the Lower Ordovician fauna of the Ching-wang-tao region north of the Kaiping basin is to the credit of Dr. F. F. Matthieu who placed the material in my hands for description, and with true scientific spirit has deposited the types and illustrated specimens in the museum of the Survey, where they are accessible to all students and specialists.

The Ordovician species at present known from north China comprise 31 genera

*) It gives me great pleasure to acknowledge the uniform courtesy and helpfulness of the officers of the various mines notably M. Alexandre Doquier Chief of Staff Tangshan, M. Maurice Derwiduee Chief engineer of the Chaokouchuang mines and Mr. Ch. P. Huang, Chief engineer of the Machiakou mines. To Messrs. Matthieu, Gerard and C. H. Huang we are also greatly indebted for efficient aid and guidance in our field-work, and to the first for placing at my disposal collections previously and since then made by him, especially in Shantung, and from the Lower Ordovician beds of the Chingwangtao region of east Chihli, this lower fauna having been discovered by him. To Mr. W. S. Nathan president of the Kailan Mining Administration special acknowledgments and thanks are gladly tendered for his courtesy in giving us unlimited opportunity to study the mines and properties in the Kaiping basin under his control, and for putting at our disposal housing accommodations, transportation and mechanical assistance.

and 58 species 45 of these being specifically identified.* All except five of the species are new. Three new genera, and a new family of cephalopods, that of the *Chihlioceratidæ* are described.

STRATIGRAPHIC SUMMARY.

Willis and Blackwelder applied the name *Tsinan formation* to the entire Ordovician series of North China, which they regarded as a unit. The name was taken from Tsi-nan-fu in Shantung near which the upper beds of the series are well exposed. It is now known that there are several Ordovician formations in north China, with probably a disconformity between the higher and the lower divisions. The base of the Ordovician has been definitely located in the vicinity of the little hamlet of Yehli, about 9 li or about 3.6 miles east-north-east of Machiakou in the Kaiping Coal Basin. Here the Ordovician beds rest disconformably upon the Upper Cambrian or Cambro-Ordovician transition beds, the *Fêngshan formation*, which carries a fauna recalling the *Ceratopyge* fauna of Europe, including a new species of *Ceratopyge*. The disconformity is marked by an irregular erosion surface of the Fêngshan formation followed by a basal conglomerate which marks the beginning of the Ordovician limestones **).

To the limestone immediately succeeding this basal conglomerate we have given the name *Yehli formation*, and from it the following species have been obtained.

CEPHALOPODA

Suecoceras yehliense Grabau

Suecoceras attenuatum Grabau

Extremely meager as this fauna is, it is sufficient to indicate early Ordovician, but whether it is Lower or early Middle Ordovician must for the present remain undetermined. The limestones of this region have a total thickness, according to the measurements of Mr. H. C. T'an, of approximately 800 meters, but whether this series is continuous or separated into two divisions by a hiatus, has not yet been ascertained.

UPPER ORDOVICIAN

The upper beds of the Ordovician of the Kaiping basin are well exposed at Machiakou, south-west of Yehli, and from this locality the formation is named the *Machia-kou division* or Machiakou formation. This is the typical *Actinoceras limestone*, widely exposed in the Kaiping basin from Chaokouchuang on the east to Tangshan on the west. It is again known by fossils from the Western Hills of Peking, from the Shansi border,

*) This includes two varieties. Two others have been tentatively referred to known species.

**) This will be described by the author in the Bulletin of the Geological Survey.

from south Chihli, from various parts of Shantung and from Manchuria. The fossils so far obtained from it occur in the upper 10 to 15 meters, but it must be clearly understood that over this entire region of its known-exposure it has suffered pre-Carboniferous erosion, and that beds of late Palæozoic age - usually Lower Carboniferous or Dinantian, but sometimes Upper Carboniferous or Uralian and in some cases perhaps Permo-Carboniferous beds rest upon them. Thus the fossiliferous upper beds are probably not always of the same horizon, though it is possible that *Actinoceras* may have only a limited vertical range, in which case the pre-Carboniferous erosion over wide areas was relatively uniform in amount.

FAUNA OF THE MACHIAKOU OR ACTINOCERAS LIMESTONE

The following species have been obtained from the upper part of the Machiakou or Actinoceras limestone *).

BRACHIOPODA

- 1 *Orthis calligramma* Dalm. var. *orthambonites* (de Vern.), Chihli
- * 2 *Orthis?* sp., Shantung (Weller)
- * 3 *Dalmanella* cf. *testudinaria* Dalm., Shantung (Crick, Frech)
- 4 *Strophomena* cf. *incurvata* (Shepard), Chihli
- * 5 *Strophomena* sp., Shantung (Weller)
- * 6 *Plectambonites sericeus* (Sow.), Shantung (Lorenz)

PELECYPODA

- 7 *Ctenodonta symmetrica* Grabau, Chihli

GASTROPODA

- * 8 *Machurea?* or *Helicotoma?* sp., Shantung (Weller)
- * 9 *Machurea logani* Salter, Shantung (Lorenz)
- 10 *Eccyliopterus kushanensis* Grabau, Chihli
- 11 *Eccyliomphalus tangshanensis* Grabau, Chihli
- 12 *Lophospira morrisi* Grabau, Chihli
- 13 *Lophospira pulchelliformis* Grabau, Chihli
- 14 *Lophospira trochiformis* Grabau, Chihli
- 15 *Lophospira acuta* Grabau, Chihli
- 16 *Lophospira gerardi* Grabau, Chihli
- 17 *Lophospira gerardi* var. *laxa* Grabau, Chihli

*). The species preceded by and asterisk are recorded by Crick, Weller, Lorenz, Frech etc. from Shantung and one No. 34, from Manchuria. All of these, except the last, I have not seen.

- 18 *Lophospira terrassa* Grabau, Chihli
- 19 *Lophospira obscura* Grabau, Chihli
- * 20 *Lophospira* sp., Shantung (Weller)
- 21 *Pagodispira derwiduii* Grabau, Chihli
- 22 *Pagodispira dorothea* Grabau, Chihli
- 23 *Pagodispira dorothea* var. *laxa* Grabau, Chihli
- 24 *Liospira barbouri* Grabau, Chihli
- * 25 *Liospira* sp. (*Raphistoma* cf. *æquilaterum* Koken, Frech), Manchuria (Frech)
- 26 *Salpingostoma terrilli* Grabau, Chihli

CONULARIDA

- * 27 *Hyolithes* sp., Shantung (Lorenz)

CEPHALOPODA

- 28 *Vaginoceras tsinanense* Grabau, Chihli
- * 29 *Orthoceras* sp. (several), Shantung (Weller)
- 30 *Cycloceras?* *peitoutzense* Grabau, Chihli
- 31 *Stereoplasmodoceras pseudoseptatum* Grabau, Chihli, Shantung
- 32 *Stereoplasmodoceras machiakounense* Grabau, Chihli, Shantung
- 33 *Stereoplasmodoceras actinoceriforme* Grabau, Chihli
- 34 *Actinoceras richthofeni* Frech, Chihli, Shantung, Manchuria (Frech)
- 35 *Actinoceras tani* Grabau, Chihli, Shantung
- 36 *Actinoceras coulingi* Grabau, Shantung (Crick), Honan, Chihli
- 37 *Actinoceras suanpanoides* Grabau, Shantung
- 38 *Actinoceras submarginale* Grabau, Chihli
- 39 *Actinoceras nanum* Grabau, Chihli
- 40 *Actinoceras curvatum* Grabau, Shantung
- 41 *Cyrtactinoceras frechi* Grabau, Chihli, Shantung
- 42 *Gonioceras shantungense* Grabau, Shantung
- * 43 *Trochoceras* sp., Shantung (Frech)

TRILOBITÆ

- 44 *Asaphus bachmi* Lorenz, Shantung (Lorenz), Chihli
- 45 *Asaphus?* sp. or *Isotelus* sp., Chihli
- * 46 *Asaphus?* sp., Shantung (Weller)

A consideration of this fauna clearly shows it to be of early Upper Ordovician age corresponding to the fauna of the Black River limestone of New York and Canada and to

the early Trenton beds of the central and eastern United States and Canada. Although no species can be said to be absolutely identical, (except perhaps *Actinoceras richthofeni*, with which is identified a specimen figured by Barrande from Canada*) still the majority are representatives of species occurring in the American early Upper Ordovician formations, and indeed, in some cases these Chinese species are hardly more than geographical varieties of the American forms. As such they indicate a very close correspondence of horizons. The presence in our Chinese fauna, of forms closely analogous to species found in the Stones River or upper Middle Ordovician of North America, indicates that the horizon is to be regarded as at the boundary-line between Middle and Upper Ordovician. Thus it is quite safe to correlate the *Actinoceras* horizon essentially with the Black River formation of North America. How much of the underlying series of limestones represents Middle Ordovician and what part is of Early Ordovician age, cannot at present be determined.

The only European form I have noted in addition to those recorded by Crick, Lorenz and Frech, is *Orthis calligramma* variety *orthambonites*, of the type figured by de Verneuil from Russia.

LOWER ORDOVICIAN.

Undoubted Lower Ordovician fossils were discovered by Dr. F. F. Matthieu in the Shi-mun-chai region northwest of Ching-wang-tao in northeastern Chihli. The stratigraphic succession here is as follows according to Dr. Matthieu.**)

CARBONIFEROUS FORMATION

(Great hiatus and disconformity)

ORDOVICIAN FORMATION

<i>Liangchiashan formation</i>	275 m.
Gray massive more or less dolomitic limestone with fossiliferous horizon	
(F3) 53 m. below the top.	129 m.
Limestone conglomerate (intraformational)	1 m.
Gray massive limestone	118 m.
Conglomeratic limestone, grayish blue	1 m.
Pale grayish limestone in thin layers	26 m.
<i>Shihmunchai formation</i>	155 m.
Interstratified sill	6 m.

*). The presence in this limestone in Shantung of *Dalmanella cf. testudinaria* and *Plectambonites sericeus* as recorded by Crick, Lorenz and Frech also suggests early Trenton, while *Maclurea logani* recorded by Lorenz again suggests the Black River, being known from that horizon in Canada as well as from Europe.

**). The stratigraphy of this region will be more fully discussed by Dr. Matthieu in a forthcoming Bulletin of the Survey.

Shales and shaly limestones, yellowish gray to violet...	79 m.
Brownish and red limestone conglomerate ...	5 m.
Platey limestone ...	17 m.
Interstratified sill ...	7 m.
Shales and shaly limestones ...	22 m.
Limestone ...	5 m.
Brown shales and calcarenites ...	13 m.
Brownish-red limestone conglomerate ...	1 m.
<i>Peilintze formation</i> (exposed) ...	95 m.
Öolitic limestone ...	23 m.
Bluish black massive limestone with fossil horizons F2, 10 meters and F1, 33 meters below the top ...	72 m.
Base not exposed	
<i>Total exposed thickness of Ordovician</i> ...	525 m.

The most significant fact revealed by the study of this section is the absence of the Machiakou or Actinoceras limestone, which over such a wide area directly underlies the Carboniferous formations. This indicates a very pronounced pre-Carboniferous erosion in this region and further, a marked irregularity of attitude of the Ordovician strata, for a short distance to the south the higher limestones are present, and they are again found further to the north in Manchuria.

PEILINTZE LIMESTONE.—A noteworthy fact is the apparent entire distinctness of the two faunas found in the limestones of this section. The fauna of the lower or *Peilintze limestone* at present comprises the following species:

ACTINOZOA (?)

- 1 *Archæocyathus* (*Archæoscyphia*) *chihliense* Grabau

GASTROPODA

- 2 *Ophileta squamosa* Grabau
- 3 *Fusispira* sp.

CEPHALOPODA

- 4 *Protocameroceras matthiewi* Grabau
- 5 *Chihlioceras nathani* Grabau
- 6 *Chihlioceras chingwangtaoense* Grabau
- ? 7 *Piloceras platyventrum* Grabau (doubtful from this horizon).

The presence of *Archæocyathus* in this fauna is noteworthy. This genus, and indeed all of the *Archæocyathinæ*, are typical of Cambrian horizons, occurring most

commonly in the Lower Cambrian. One species however *A. minganense* Bill. has been obtained from the Lower Ordovician of the Mingan Islands eastern Canada. This species has no inner wall and has been made by Hinde the type of his new genus *Archæoscyphia*. Our species is of the same generic type. The occurrence of this fossil, which appears to be fairly common, is sufficient indication that the Peilintze limestone represents lowest Ordovician. The presence of a *Protocameroceras* very similar to *P. brainardi* of the American Beekmantown, further indicates the correctness of this classification, as does also the presence of *Ophileta*. *Chihlioceras* represents a new type of cephalopod and for it the new family of the *Chihlioceratidæ* is erected. Its nearest relation is *Piloceras*, but it is very distinct from this in its siphuncular structure, which, curiously enough, is much more specialized and complicated than is that of *Piloceras*. The presence in this fauna of the species of the latter genus, characteristic of the higher formation, is open to some doubt, as it is possible that there may have been a mislabeling of specimens in the field. If it really belongs here, it is the only species which the two divisions have in common.

The base of the Peilintze limestone has not yet been found, and its relationship to the older horizons is therefore unknown. All of the material here described comes from the lowest fossiliferous horizon (F 1) except one fragment which contains several specimens of *Ophileta* apparently of the same species as that in the lower horizon, though the material is rather imperfectly preserved. This comes from F 2.

LIANCHIASHAN LIMESTONE.—No fossils have been obtained from the intermediate shales and limestone of the *Shihmunchai* formation. The upper or *Lianchiashan* limestones carry a fossil horizon (F 3) 223 meters above the base. At this level the following species occur.

GASTROPODA

- 1 *Ophileta plana* Grabau
- 2 *Hormotoma doquieri* Grabau

CEPHALOPODA

- 3 *Cameroceras styliforme* Grabau
- 4 *Piloceras platyventrum* Grabau

This is a small but distinctive fauna, and one confined to this horizon unless the presence of *Piloceras platyventrum* in the lower beds should be substantiated. Both the *Piloceras* and the *Ophileta* indicate Lower Ordovician, or a horizon approximately equivalent to the upper Beekmantown of North America. *Hormotoma* indicates a somewhat higher horizon and the fauna may perhaps represent early Middle Ordovician, but can scarcely be higher so far as the known species permit us to judge.

The relationship of these faunas to the Ordovician faunas of the Kaiping basin farther south, is still obscure. The beds which there rest disconformably upon the Upper Cambrian have so far furnished few fossils only, all of which are entirely unknown in either of the two horizons in the Shih-mun-chai region. Further search may of course

bring common species to light, and demonstrate the correspondence of the Yehli limestone series to one or the other of the formations in the more northern region. When such new material is obtained, it will be described in further numbers of this publication.

DESCRIPTION OF SPECIES

Class **ANTHOZOA**

Family **ARCHÆOCYATHINAE**

Genus **ARCHÆOCYATHUS** Billings

(Subgenus *Archæoscyphia* Hinde)

Archæocyathus (Archæoscyphia) chihliense Grabau (sp. nov.)

Plate I Figs. 1-3

Caliculus irregularly sub-conical, apparently expanding in a uniform manner. Basal portion unknown. Adult portion sub-circular to sub-oval in transverse section, the latter possibly accentuated by compression in some specimens. Septate portion (*thecarium*) thick, enclosing a hollow calicular cavity which, in the subcylindrical specimens, has a diameter something over one third the diameter of the entire caliculus. This cavity is well defined by the inner ends of the main septa, which attain a uniform length, but are not bounded by any definite inner wall, or endotheca. Outer wall or exotheca formed by the thickening of the outer ends of the septa, and their irregular confluence, the result being a very porous wall.

Septa thin, formed apparently by a series of small confluent trabeculae, this resulting in the production of thin radial plates of a very porous nature, so that in transverse section they appear as disconnected trabeculae, disposed in radial lines. They are very numerous and arranged in groups of three or four each, the groups being separated by interspaces which are about twice as wide as the interspaces between the adjoining septa of a group. Occasionally one of these broader interspaces is occupied by a short septum in the peripheral region.

A section 28 mm. in diameter (Pl I fig. 3), shows about 33 groups of septa, making a total of from 100 to 120 septa. The specimen from which this section is cut appears to have had a somewhat flaring outer edge to its calyx, a section of this showing on one side, because of slight obliquity of the cut. In this outer portion the septa are