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THE ORDOVICIAN CEPHALOPODA OF CENTRAL CHINA

BY

C. C. YÜ

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V. K. Ting and Y. C. Sun

The Ordovician Cephalopoda of Central China

BY

C. C. YÜ

Geologist to the National Research Institute of Geology

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THE ORDOVICIAN CEPHALOPODA OF CENTRAL CHINA

by

C. C. Yü.

INTRODUCTION

When I carried on the field work in Hsien-ning-hsien (咸寧縣), gathering many beautiful well-preserved Silurian fossils in May of the year 1928, Messrs C. Li and W. P. Shu had simultaneously made a collection of orthoceracone Nautilids in large numbers from the Ordovician beds at San-shan-yuan (三山原), He-chiao (黑橋), and some other localities of Ch'ung-yang-hsien (崇陽縣), distant about sixty li or a little more than twenty miles southwest of Hsien-ning-hsien. Moreover, the Ordovician cephalopods are also found in the regions to the south-west of Pu-chi-hsien (蒲圻縣), and the south-east of Hsien-ning-hsien. The specimens in this collection are mostly of large size, some attaining nearly one meter in length. Nevertheless, their preservation is rarely perfect. In the majority of cases these cephalopods are obtained from the polished slabs of the dark-gray limestone, where the shell has been partly weathered away on one side, while the remaining portion is seldom separable from the rock on the other side; and therefore no trace of the surface markings has been recognized. Thus the determination of these fossils is based entirely on the internal characters.

During October of the same year, Mr. Shu and I went to northern Hupeh, and in our field work covered the area of I-chêng (宜城), Chung-hsiang (鍾祥), Ching-shan (京山), Ching-men (荊門) and Nan-chang-hsien (南漳). In this trip we collected an abundance of delicate fossils from the different geological horizons ranging from Sinian to Jurassic, though the Devonian and the Triassic deposits have not furnished fossils so far. In this collection the Ordovician cephalopods appear to be one of the dominant types. They are very abundant and wide-spread over the region of northern Hupeh. As our journey required haste, the time was not sufficient to enable us to stay long enough at many of the localities to make more extended collections of fossils.

The specimens brought back to the Institute from the field during these trips amount to a large number. Unfortunately, the palæontological publications are not

yet complete enough in our Institute library which was just established last year, so the palæontological work is not possible at present at the Institute. Therefore on the first of March of the year 1929, Prof. Lee granted me leave to bring this material to the Geological Survey in Peiping for the purpose of identification and description of these specimens under the direction of Prof. Grabau, the chief Palæontologist to the Surveys

After I had finished the work of describing the Ordovician cephalopods brought here from our Institute, Prof. Grabau asked me to continue to take up some other cephalopods collected by Prof. J. S. Lee and Mr. C. Y. Hsieh, and a similar collection presented to the Survey by the late J. Langford Smith. In 1924 Prof. Lee made an excursion to the Yangtze Gorges, collecting some cephalopods and many other fossil. from the Neichiashan formation. Mr. Hsieh also obtained very abundant Ordovician cephalopods, which were partly from the upper part of Tafang limestone at Yang-sing-hsien (陽新縣), eastern Hupeh in 1923, and partly from the western Hupeh in the autumn of the year 1924. Though these collections consist of a large quantity of specimens, the number of species is not very great. Besides, the majority of them are conspecific, not only congeneric, with those collected by myself, but some specimens such as *Cameroceras*, *Protocycloceras* etc. have not been met with in the localities of northern Hupeh.

First of all I would express my special indebtedness to Prof. A. W. Grabau for his courtesy in giving me much valuable suggestions and criticisms. To Prof. J. S. Lee Director of the Institute, Dr. W. H. Wong, Director of the Geological Survey, Dr. V. K. Ting, Editor of the Palæontologia Sinica of China and Dr. Y. C. Sun President of the Palæontological Society of China I am also indebted for furnishing me every facility for carrying on the palæontological work in the Survey laboratory. Finally, I particularly tender my deep appreciation to Mr. K. H. Hsü and Mr. Y. S. Chi for their help in the photographic work.

TERMINOLOGY

All Nautiloids are provided with an external shell, which may be termed *ceracone* or *conch*. When the shell is straight, it is called *orthoceracone;* when curved, *cyrtoceracone*. If the conch is curved in a loose coiling manner it is called *gyroceracone;* and closely coiled having the impressed zone, called *nautilicone*. The embryonal shell is known as the *protoconch;* and the septate shell, the *phragmacone*. The interior of the shell consists of many transverse partitions or *septa*. The spaces confined between the septa are the *chambers* or *cameræ*. The *chamber of habitation, body chamber* or the *living chamber* is the last chamber occupied by the body of the animal. There is a small hollow tube or *siphuncle*, which passes through all the septa, occupying a different position in different genera. The septa abruptly bend backward and continue to a certain extent around

the siphuncle. Their prolongations, called *septal necks* or *septal funnels*, are either short as in Orthochoanites, or very long as in the Holochoanites.

In Holochoanites as usually described there is another small axial tube existing in the center of the siphuncle, which is called *endosiphotube* or *endosiphuncle* by Hyatt or *prosiphon* by Zittel. The siphuncle is more or less solidly filled with thin calcareous cones or *endosiphosheaths* around the endosiphuncle. There is a conical cavity formed by the last *endosiphosheath*, which is termed *endosiphocone* or *endocone by* Hyatt. It extends forward into the open space of the *siphuncle* known as the *endosiphocylinder* (*endoconal* or *siphuncular chamber* of Hyatt). The *endosipholining* is the additional covering on the inside of the siphuncular wall which is composed of the septal funnels.

Recently Prof. Grabau has shown that the so-called siphuncle of the Holochoanites is homologous with the shell of the Orthochoanites, the endosipholining of the former corresponding to the wall of the latter, and the endosiphosheaths to the septa. He has proposed the following terms[1] for use in the shells of Holochoanites, which are adopted in the present paper.

Ectoconch.....The outer shell of former authors (exclusive of siphuncle).

Endoconch.....The siphuncle of former authors.

Ectotheca.....The outer shell wall of authors.

Endotheca.....The inner shell wall or endosipholining of authors (often absent).

Ectosepta.....The septa of outer shell of authors.

Endosepta.....The septa of inner shell or the endosiphosheaths of authors.

Tubus (pl. *tubi*).....The prolongations of the ectosepta homologized by former authors with the septal funnels of the Orthochoanites.

Endosiphuncle.....The siphuncle of the endoconch or endosiphuncle of authors.

Endocone.....Terminal conical living chamber of endoconch or endosiphocone of authors.

Endocylinder.....The endosiphocylinder of authors.

1. These terms have been published in the Bulletin of the Geological Society of China, Vol. 8, No. 2, p. 118.

STRATIGRAPHY

COMPARISON OF THE ORDOVICIAN BEDS IN THE DIFFERENT LOCALITIES OF HUPEH.

Although the Ordovician beds at the different localities in Hupeh have been studided and the results published at various times by other geologists and by the author, nevertheless they will also be briefly summarized here for convenience in comparison. In the first place we shall take the Ordovician strata in western Hupeh into consideration, which region may be regarded as the type locality of Ordovician formations in Hupeh province or even in Central China.

1. WESTERN HUPEH:[1] At Nant'ou on the Yangtze River above I-chang, and on the Ta-ning-ho in Ki-sin-ling pass Willis and Blackwelder[2] found that there is a very thick massive limestone overlying the Nan-t'ou tillite and attaining a thickness of more than 1,200 meters in the Nant'ou section. They called it the Ki-sin-ling limestone and held that it represented the Cambro-Ordovician period. On the uppermost part of the Ki-sin-ling limestone, as described by them there are green calcareous shales alternating with nodular limestone about 60 meters thick, which directly underlie the Sint'an formation. In the spring of the year 1924, Prof. Lee carried on detailed stratigraphical work on the geology of the Yangtze Gorge[3]. He discovered that the so-called Ki-sin-ling limestone not only comprises the rocks of Cambrian and Ordovician periods, but also the entire Sinian system, the first period of the Palæozoic as proposed by Prof. Grabau[4]. Prof. Lee suggested another group name "Niukan Group" for the actual Cambro-Ordovician strata so well exposed in the Niukan Gorge instead of the so-called Ki-sin-ling formation. According to Prof. Lee's proposal the Niukan Group may also be, from the fossil fauna point of view, divided into the Shipai shale at the

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1. Messrs. Hsieh and Liu had taken a geological trip to south-western Hupeh in April of 1925 (Bulletin of the Geological Survey of China, No. 9), and Mr. H. M. Meng to north-western Hupeh in the autumn of 1928 (Memoir of Institute of Geology, No. 8. National Research Institute of China). According to their reports the Ordovician beds at these localities are quite similar to those of western Hupeh and numerous *Orthoceras* were also seen in the Neichiashan formation. Now we know that the so-called "Pagoda stone" at Hupeh province includes the orthoceracone Nautilids which are not only *Orthoceras chinense* Food, but also many other forms of different species or even of different genera as well. It is unfortunate that they did not bring any specimen back. So we can not discuss them here.

2. Willis and Blackwelder: Research in China, Vol. I, pt. I, pp. 269-272.

3. J. S. Lee: Geology of the Yangtze Gorge. Bulletin of the Geological Society of China, Vol. III, No. 3-4.

4. A. W. Grabau: The Sinian System. Bulletin of the Geological Society of China, Vol. I, p. 44.

lower part, and Ichang limestone as well as Neichiashan Series at the Upper, the former one denoting the Cambrian deposit and the latter two the Ordovician. The I-chang limestone attains a thickness of from 1250 m. to 1680 m. and yields fossils of Lower Ordovician age such as *Callograptus* cf *salteri* Hall, *Proterocameroceras mathieui* Grabau, *Eccyliopterus*. sp., *Asaphus sp. Archæocyathus chiliensis* Grabau, *Girvanella sinensis* Yabe etc. The Ichang limestone is again disconformably overlaid by the Neichiashan Series, 110 m. thick, which consists of two parts. The lower part is an alternation of green, calcareous shales and brownish yellow or light gray limestone characterized by *Triplecia (Yangtzeella) poloi* (Martelli) Kolarova, and *Clitambonites giraldii* Martelli; and the upper one is a dense gray limestone crowded with abundant *Orthoceras*. This series has furnished besides *Triplecia (Yangtzeella) poloi* Martelli, and *Clitambonites giraldii* Martelli, the following: *Orthis calligramma* Dalm., *Eccyliopterus sinensis* Frech, *Vaginoceras duplex* Wahlenberg, *Discoceras eurasiaticum* Frech, *Endoceras* sp., *Cycloceras* sp., *Cyrtoceras* sp., *Asaphus* cf *expansus* Dalm., and many specimens of *Orthoceras*. A preliminary determination of the cephalopods in this collection was made by Prof. Grabau, but some are missing from the Geological Museum of Peking University except the specimens of *Orthoceras chinense* Foord, *Discoceras eurasiaticum* Frech and the so-called *Cyrtoceras* which now is known as *Meloceras asiaticum* Yabe. During the autumn of 1924 Messrs. C. Y. Hsieh and Y. T. Chao again carried on field work in the western part of Hupeh[1] and collected one species of cephalopod from the Ichang limestone and a lot of them mainly from the upper part of the Neichiashan formation at the places near Lo-jo-ping and Chien-yang-ping. Prof. Grabau asked me to make a thorough study of these cephalopods of which he has made a preliminary examination. The material includes the following species:

a. From Ichang limestone
   Cameroceras cf. *styliforme* Grabau

b. From Neichiashan formation (upper part)
   Cameroceras tenuiseptum Hall var. *ellipticum* Yü
   Cameroceras hsiehi Yü
   Cameroceras subtile Yü
   Cameroceras sp.
   Vaginoceras neichianense Yü
   Vaginoceras reedi Yü
   Vaginoceras multiplectoseptatum Yü

1. C. Y. Hsieh and Y. T. Chao: Geology of I-chang, Hsing-shan, Tze-kuei and Pa-tung districts, W. Hupeh. Bulletin of the Geological Survey of China. No, 7.

Orthoceras chinense Foord
Orthoceras regulare Schlotheim
Orthoceras squamatulum Barrande
Orthoceras thyrsus? Barrande
Orthoceras yangtzeense Yü
Orthoceras? wongi Yü
Protocycloceras deprati Reed

2. EASTERN HUPEH: The stratigraphical work of eastern Hupeh had been done by Mr. Seijiro Noda[1], but his classification was found incorrect by Messrs. Hsieh and Liu who were sent by the Geological Survey of China to study the geology of Yang-sing and other districts[2] in the autumn of 1923. They reported that the Ordovician limestone at these localities is very thick and gray in colour. Because it was first found at Ta-fang village in Yang-sing district, the Ordovician formation is called Tafang limestone. Its actual thickness is unknown, because the basal part is not exposed. Some *Orthoceras* and brachiopods are found in the limestone, and are very abundant together with some trilobites in a layer of purple calcareous shale about 20 m. thick on the top of the formation, which is regarded as the equivalent of the upper part of the Neichiashan Series. The cephalopods of the collection now preserved in the laboratory of the Survey are:

Vaginoceras belemnitiforme Holm
Vaginoceras endocylindricum Yü
Vaginoceras uniforme Yü

3. SOUTH-EASTERN HUPEH: According to Mr. Li's Report[3] on the geology of Pu-chi, Hsien-ning etc., it is shown that the Ordovician exposed in that area is made up of limestone, which appears to be divided into two divisions. The lower division is a thick-bedded dark gray limestone, of which the exposed thickness amounts to about 500 m. The upper division consists of an alternation of reddish thin-bedded limestone and calcareous shale, which attain a thickness of 140 m. overlying a layer of the yellowish gray thin-bedded limestone 30 m. thick at its base. Many cephalopods of large size were obtained, especially from the basal bed of the upper division. A comparison of this upper division with the Neichiashan formation of western Hupeh brings out the fact that though other fossils than the cephalopods in

1. Geographical research in South China, Vol. II, pp. 241-281.

2. C. Y. Hsieh: Stratigraphy of south-eastern Hupeh. Bulletin of the Geological Society of China, Vol. III, No. 2.

3. C. Li: Geology of Pu-chi, Kia-yu, Hsien-ning, Chung-yang and Wu-chang districts, Hupeh Province. Memoir of the Institute of Geology, No. III, National Research Institute of China.

that formation have not been found in this upper division, and though their lithological characters also differ to some degree, nevertheless some cephalopods from this division are of the type of those common in the upper part of Neichiashan formation on the one hand and others correspond to those obtained from the top of Tafang limestone on the other. It is quite possible to say that this upper division may be compared with the upper part of Neichiashan formation. The cephalopods secured from this division include the following species:

Endoceras leei Yü
Vaginoceras wahlenbergi Foord. var. *cylindrica* Yü
Vaginoceras endocylindricum Yü
Vaginoceras peiyangense Yü
Vaginoceras shui Yü
Vaginoceras neichianense Yü
Vaginoceras uniforme Yü
Vaginoceras giganteum Yü
Vaginoceras sp.
Orthoceras chinense Foord var. *eccentrica* Yü
Orthoceras chinense Food var. *equiseptatum* Yü
Orthoceras rudum Yü
Orthoceras suni Yü
Orthoceras elongatum Yü
Orthoceras sp.
Lituites lii Yü

4. Northern Hupeh: In northern Hupeh[1] the Ordovician deposit is quite similar to that in the western part of Hupeh, comprising the so-called Ichang limestone in the lower part and the Neichiashan formation in the upper. The former attains a thickness of more than one thousand meters while the latter is rather thin in proportion, having only a total thickness of about eighty meters or a little more. The Neichiashan formation also consists of two parts. The lower part is yellowish green shale about twenty meters thick, and the upper is light greenish argillaceous limestone reaching a thickness of sixty meters or more. It is to be noted that this formation is distributed over a wide area in Hupeh province. As we travelled across these localities namely: Nan-chang, Chung-hsiang, I-cheng, Chingshan and the southern border of Hsiang-yang-hsien, the Neichiashan formation with its striking cephalopod fauna

1. C. C. Yü and W. P. Shu: Geology of Hsiang-yang, Nan-chang, I-cheng, Ching-men, Chung-hsiang and Ching-shan districts, North Hupeh. Memoir of the Institute of geology, No. VIII, National Research Institute of China.

was frequently met with here and there. Its upper part or the limestone bed is characterized by the different forms of Orthochoanites and Holochoanites, and its lower part or the shale bed yields the well-preserved specimens of Graptolites, Trilobites, Brachiopods and some others, but not the characteristic *Yangtzeella poloi* (Martelli) which, however, occurs very abundantly in western Hupeh. This formation has so far furnished the following fossils:

a. In the upper part of the Neichiashan formation.

Endoceras grabaui Yü
Vaginoceras (*Endoceras*) *wahlenbergi* Foord
Vaginoceras chientzekouense Yü
Orthoceras chinense Foord
Orthoceras chinense Foord var. *kuangchiaoense* Yü
Orthocecas chinense Food var. *equiseptatum* Yü
Orthoceras cf. *politum* M'Coy
Orthoceras remotum Yü
Orthoceras densum Yü
Orthoceras sp.
Cycloceras sp.

b. In the lower part of the Neichiashan formation.

Didymograptus murchisoni Beck
Orthis calligramma Dalm.
Dalmanella sp.
Leperditia sp.
Asaphus gigas var. *hupehensis* Sun
Taihungshania shui Sun
Illænus nanchangensis Sun
Bathyurus minor Sun
Bronteus sp.

THE GEOLOGICAL HORIZON OF THE SO-CALLED NEICHIASHAN AND ICHANG FORMATIONS.

So far as we know, the upper part of the Ichang limestone belongs to the Lower Ordovician, for Prof. Lee and Mr. Hsieh had collected, in beds not far from the base of overlying Neichiashan formation, some fossils, which, according to Prof. Grabau's determination, are of Lower Ordovician age. But the age of the lower part of Ichang formation already discussed by Yabe, Hsieh and others is quite uncertain. Prof. Grabau,

however, believes it is more likely of Lower Ordovician rather than Cambrian age. Unfortunately, Mr. Shu and I also have not discovered, in our extensive journey in northern Hupeh, any characteristic fauna other than the so-called *Archæocyathus* from the basal part of Ichang formation, which could throw more light on this unsettled question.

The geological horizon of the Neichiashan formation has been considered by many previous authors to be Middle Ordovician or lowest Upper Ordovician. Mr. Shu and I obtained from the lower part of this formation just underlying the cephalopod-bearing bed at Tai-hung-shan, 3 li west of Nan-chang district, many specimens of a well-preserved characteristic graptolite, namely *Didymograptus murchisoni* Beck, which had not been found by any former traveller in Hupeh province and its neighbouring localities. From this characteristic graptolite we may readily conclude that the lower part of the Neichiashan formation actually corresponds to the *Didymograptus murchisoni* zone of the British Ordovician rocks, while the cephalopods contained in the upper part of the formation and described in the present paper show approximate equivalency to the Orthoceras limestone of Sweden and the Vaginoceras limestone of the Baltic province of Russia.

THE RELATIONSHIP BETWEEN THE ORDOVICIAN CEPHALOPODS FROM HUPEH, CENTRAL CHINA AND THOSE FROM THE CORRESPONDING HORIZON IN NORTHERN AS WELL AS SOUTHERN CHINA.

Before comparing the cephalopod faunas of North and Central China, we must summarize the distribution of the Ordovician cephalopods collected at various times from the different localities in China.

1. IN MANCHURIA.

a. From Hsiau-sörr, Fengtien, Richthofen collected the following form which was described by Frech[1] and referred by him to the Upper Ordovician. Prof. Grabau, however, recognized that this bed is of the same horizon as the Machiakou limestone in Chihli.

Actinoceras richthofeni Frech

b. In the year 1928 T. Kobayashi described many Ordovician cephalopods from Corea and South Manchuria.[2] Those collected from the Tofango fossil bed at To-fan-go and Niu-shin-tai of Fengtien province are of the same horizon as the Machiakou limestone. The species are as follows:

1. F. Frech: In Richthofen's China, Vol. V, p. 8.

2. T. Kobayashi: Ordovician Fossils from Corea and South Manchuria. Japanese Journal of Geology and Geography, Vol V, No. 4.

Cycloceras (?) *peitoutzense* Grabau
Stereoplasmoceras pseudoseptatum Grabau
Stereoplasmoceras submarginale Kobayashi
Stereoplasmoceras subcentrale Kobayashi
Tofangoceras pauciannulatum Kobayashi
Tofangoceras irregulare Kobayashi
Actinoceras richthofeni Frech
Actinoceras tani Grabau
Actinoceras coulingi Grabau
Actinoceras manchurense Kobayashi
Actinoceras submarginale Grabau
Actinoceras nanum Grabau
Actinoceras harioi Kobayashi
Actinoceras suanpanoides Grabau
Actinoceras curvatum Grabau
Actinoceras murakamii Kobayashi
Cyrtactinoceras mitsuishii Kobayashi
Discoactinocras multiplexum Kobayashi
Cyrtoceras (*Meloceras*) aff. *asiaticum* Yabe

2. In Chihli.

a. Many cephalopods were obtained by different individuals from the Machiakou limestone and the Lower Ordovician beds at Kai-ping basin, Shih-mun-chai and some other places, and described by Prof. Grabau.[1]

(a). Machiakou limestone

Vaginoceras tsinanense Grabau
Cycloceras? peitoutzense Grabau
Stereoplasmoceras pseudoseptatum Grabau
Stereoplasmoceras machiakouense Grabau
Stereoplasmoceras actinoceriforme Grabau
Actinoceras richthofeni Frech.
Actinoceras tani Grabau
Actinoceras coulingi Grabau
Actinoceras submarginale Grabau
Actinaceras nanum Grabau
Cyrtactinoceras frechi Grabau

1. A. W. Grabau: Ordovician Fossils from North China. Palæontologia Sinica, Ser. B., Vol. I. fasc. 1.

(b). Lower Ordovician limestone

Proterocameroceras mathieui Grabau.
Cameroceras styliforme Grabau
Chihlioceras nathani Grabau
Chihlioceras chingwangtaoense Grabau
Piloceras platyventrum Grabau
Suecoceras yehliense Grabau
Suecoceras attenuatum Grabau.

b. Mr. T. K. Huang had gathered some cephalopods from Hsi-shan or Western Hills of Peking[1].

(a) Machiakou limestone

Stereoplasmoceras pseudoseptatum Grabau
Actinoceras coulingi Grabau
Actinoceras suanpanoides Grabau

(b) Peilintze limestone

Proterocameroceras minor Grabau
Proterocameroceras mathieui Grabau
Piloceras platyventrum Grabau
Chihlioceras nathani Grabau
Chihlioceras sp.

3. In Shantung

Many cephalopods have been obtained. These were described by several authors.

a. Samuel Couling had collected from the locality near Ching Chow Fu, Kiao-chow, two different forms of cephalopods which G. C. Crick[2] described as those named below. Prof. Grabau,[3] however, considered them the same as the forms in brackets from the Machiakou formation.

Actinoceras (*Ormoceras*) aff. *tenuifilum* Hall. (=*Actinoceras coulingi* Grabau).

Gonioceras sp. (cf. *Gonioceras shantungense* Grabau).

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1. T. K. Huang: On the Cambrian and the Ordovician Formations of Hsishan or Western Hills of Peking. Bulletin of the Geological Society of China, Vol. VI, No. 2.

2. G. C. Crick: Straight shelled Nautiloidea from North China. Geol. Mag. London., N. S., dec. IV, Vol. X, P. 481.

3. A. W. Grabau: Loc. cit, pp, 83, 84, 91-93.

b. Frech[1] reported that there are in the British Museum some specimens of Upper Ordovician cephalopods from Shantung, but the exact locality is unknown. These fossils seem to be equivalent in horizon to those of Couling's collection.

Actinoceras sp.
Trochoceras sp.

c. Willis and Blackwelder collected some cephalopods from the Tsinan limestone of Middle Ordovician age at the following localities. Chau-mi-tien, seven and a half miles S.S.E. of Sin-tai-hsien, NE of Tsai-kia-chuang, two and seven-tenths miles SW of Yen-chuang and some other places near Tsi-nan. These cephalopods were only generically identified by Weller[2].

Orthoceras sp. (several)

d. Prof. Grabau described the following forms[3] and considered them from the same horizon as the Machiakou limestone.

Stereoplasmoceras pseudoseptatum Grabau
Stereoplasmoceras machiakouense Grabau
Actinoceras richthofeni Frech.
Actinoceras tani Grabau
Actinoceras coulingi Grabau
Actinoceras suanpanoides Grabau
Actinoceras curvatum Grabau
Cyrtactinoceras frechi Grabau
Gonioceras shantungense Grabau

4. In Honan

One species of Actinoceras has been obtained from the Machiakou limestone of Hsi-hsien[4]

Actinoceras coulingi Grabau

5. In Kiangsu Province

a. One form of cephalopod from Richthofen's collection at Lun-shan had been identified by Frech[5] with the following species apparently representing the

1. F. Frech: In Richthofen's China, Vol. V, p. 14.

2. S. Weller: A Report on Ordovician Fossils collected in Eastern Asia in 1903-4. In Research in China, Vol. III, pp. 279-280.

3. A. W. Grabau: Ordovician Fossils from North China. Palæontologia Sinica, Ser. B. Vol. I., fasc. 1.

4. A. W. Grabau: Loc. cit.

5. Frech: Richthofen's China, Vol. V. p. 2.

same geological horizon as those beds from the neighbourhood of I-chang which bear the fossils such as *Orthoceras chinense* Foord, *Discoceras eurasiaticum* Frech etc.

Endoceras duplex Wahlenberg.

b. Mr. K. Weimann Hsü also obtained some cephalopods[1] from the Lunshan limestone in the year 1924. According to Prof. Grabau's determination they are the same as the Lower Ordovician forms characteristic of the Peilingtze formation and Yehli limestone as follows:

Proterocameroceras mathieui Grabau
Suecoceras attenuatum Grabau

6. In Chekiang.

Messrs. C. C. Liu and Y. T. Chao[2] had found the following form existing in a bed of purple calcareous shale with limestone-lenses at the top layer of the Yenwashan formation of Middle Ordovician.

Orthoceras chinense Foord.

7. In Hupeh Province

Many collections of fossils were made by geologists, of which the cephalopods are the only ones concerning us here.

a. Frech considered the following cephalopods from western Hupeh[3] as referable to an Upper Ordovician fauna. However, they are now known to be of Middle Ordovician age.

Orthoceras chinense Foord
Cyrtoceras (*Meloceras*) cf. *ellipticum* Lossen
Lituites (*Ancistroceras*) *angelini* Boll.
Discoceras verbecki Frech.
Discoceras eurasiaticum Frech.

b. The following forms form Pan-tse-ya, Hu-hsi, Hsing-shan-hsien had been gathered by Noda[4] in a brownish marly limestone, which is thought to be the so-called Neichiashan formation.

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1. See "Science". Science Society of China, Vol. X, No. 4, p. 452. The forms in Mr. Hsü's collection are entirely distinct from those found by Richthofen. The relationship between these beds, which yield the different forms fossils at these two collections, is quite unknown. In this respect further researches in that locality would be necessary for settling this question.

2. C. C. Liu and Y. T. Chao: Geology of south-western Chekiang. Bulletin of the Geological Survey of China, No. 9.

3. Frech: In Richthofen's China, Vol. V. pp. 4-10.

4. In Yabe and Hayasaka's Palæontology of Southern China, p. 36.

Actinoceras (*Ormoceras*) sp. undt.
Orthoceras chinense Foord.
Cyrtoceras (*Meloceras*) *asiaticum* Yabe

Grabau[1] identified a specimen of *Actinoceras* figured by Yabe[2] from No-lu-ping, Hu-hsi, Hsing-shan-hsien as *Actinoceras coulingi* Grabau.

c. At No-lu-ping, Tung-hu-hsien, S. Usui[3] found some cephalopods in the limestone, grey in colour and earthy in texture, which is directly overlain by the Silurian deposits. From the stratigraphical point of view the fossiliferous horizon of No-lu-ping seems without doubt to be the Neichiashan formation.

Lituites (*Ancistroceras*) *angelini* Boll. var.
Discoceras eurasiaticum Frech
Discoceras sp. undt.
Orthoceras sp. undt.
Orthoceras sp. undt.

d. Prof. Lee, Messrs. Hsieh, Liu, Chao, Li, Shu and I have collected from the upper part of Neichiashan formation and its corresponding beds at different localities in Hupeh province, numerous forms of cephalopods which have been listed above. Others have been supplied by the late Mr. J. Langford Smith.

3. In the province of Sze-chuan

Only one form of cephaloped was obtained from the uppermost Ki-sin-ling limestone of Middle Ordovician age at Sü-kia-pa along the Ta-ning-ho, and identified by S. Weller[4].

Vaginoceras sp.

9. Between Yang-ko-la, Chi-chiang-hsien, Sze-chuan province, and Chu-tien-ya, Kwei-chou province,

Yamada obtained two species of cephalopods[5].

Orthoceras chinense Foord
Orthoceras sp.

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1. Grabau: Ordovician Fossils from North China, Palæontologia Sinica, Ser. B, Vol. I, Fasc. 1. pp. 83, 84.

2. Yabe and Hayasaka: Palæontology of Southern China, pl. XIX, fig. 9.

3. Loc. cit. p. 37.

4. S. Weller: A Report on Ordovician Fossils collected in Eastern Asia in 1903-4. In Research in China, Vol. III, p. 281.

5. In Yabe and Hayasaka's Palæontology of Southern China, p. 38.

10. In western Yunnan

Middle Ordovician fossils have been obtained in three localities *i.e.* Pu-piao, La-meng and Shih-tien, of which the last named has furnished the largest number of species of cephalopods (ident. by Cowper-Reed[1]).

a. Pu-piao

Orthoceras sp.

b. La-meng

Orthoceras sp.

c. Shih-tien

Endoceras wahlenbergi Foord
Endoceras cf. *cancellatum* Eichw.
Endoceras aff. *reinhardi* Boll.
Orthoceras regulare Schl.
Orthoceras cf. *kinnekullense* Foord.
Orthoceras cf. *scabrium* Ang.
O. (*Protocycloceras* ?) *deprati* Reed.
Actinoceras cf. *bigsbyi* Brown
Jovellania sp.
Cameroceras ? sp.
Cyrtoceras sp.
Spyroceras ? sp.
Trocholites yunnanensis Reed
T. aff. *macromphalus* Schrod
Lituites sp.
Tarphyceras ? sp.

According to Reed the fossiliferous beds at Shih-tien is probably equivalent to the "Vaginatenkalk" of the Baltic province, but may represent the "Echinosphæritenkalk" of Scandinavia and of the Baltic province of Russia.

So far as these cephalopods listed above are concerned, we can immediately recognize the following facts: (1) in the Middle Ordovician the *Actinocers*, which is very characteristic and abundant in North China, is very rare in Central as well as South

1. Reed: Ordovician and Silurian Fossils from Yun-nan. Palæontologia Indica, N. S., vol. VI. No. 3, pp. 62-64.

China; (2) the cephalopods of Shih-tien[1] such as *Vaginoceras* (*Endoceras*) *wahlenbergi* Foord, *Orthoceras regulare* Schl., *Protocycloceras deprati* Reed, etc. are also found in the probably contemporaneous beds of the Neichiashan formation at Hupeh; (3) among these collections from Hupeh described in the present paper, only a few forms namely *Cameroceras tenuiseptum* Hall var. *ellipticum* Yü, *Cameroceras hsiehi* Yü, etc. may be compared with North American species, but the rest have characters in common only with European types, though they are not generally conspecific with them.

Prof. Grabau has suggested that the Sino-European Ordovician fauna was derived from the Indian Ocean[2] which invaded the southern part of the East Cathaysian geosyncline in China on the one hand, and penetrated to western Europe by way of the Himalayan trough on the other. He based this primarily on the apparent migration of the graptolites in the Lower Ordovician period[3]. According to Grabau's interpretation we can understand why the Middle Ordovician cephalopods from Hupeh province which was probably covered by the southern waters, are closely related to those from South China as well as Europe, and are quite distinct from the North Chinese and North American types which belong to another source, *i. e.* the Boreal province.

One may argue that if the Indian Ocean was the home of the Sino-European Ordovician faunas, why should the characteristic *Vaginoceras* (*End.*) *wahlenbergi* Foord, which according to Foord's description[4] was collected from the Orthoceras-Limestone (referred by him to the Arenig) at typical localities in Sweden, Norway, Russia etc., makes its first appearance in the Middle Ordovician beds of southern as well as central China where the distance from the Indian Ocean is much nearer than that in the western Europe. Now this question is easily answered if we have read over what is called "Comparison of American and European Lower Ordovician formations" by Prof. Grabau[5] in which he corrected the old misconception of the unity of the "Orthoceras limestone". In Kinnekulle, Sweden the general Ordovician succession is as follows:

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1. Mr. S. S. Yoh had obtained many fossils, which are quite comparably to Brown's collection from the Middle Ordovician beds of Shihtien, from the Shihtzupu shale at Shih-tzu-pu, 10 li north of Tsung-yi district, Kuei-chow Province. But he did not find any cephalopod. (Bulletin of the Geol. Surv. of China, No. 11, p. 33.).

2. Grabau: China in the Ordovician Period. Bulletin of the Geological Society of the National University, Peking, Vol. III, pp. 9-22.

3. Grabau: Origin, Distribution, and Mode of Preservation of the Graptolites. Memoir of the Institute of Geology, No. VII, pp. 1-52. National Research Institute of China.

4. Foord: Catalogue of Fossil Cephalopoda, Pt. I., pp. 136-140.

5. See Bulletin of the Geological Society of America, Vol. 27, pp. 555-622.

Silurian

.....*Hiatus and disconformity* .....

Ordovician

Brachiopod shale

.....*Hiatus and disconformity*.....

Trinucleus shale

Chasmops beds, dark shales with graptolites and numerous concretionary limestone masses and beds of impure limestone containing *Chasmops sp.*, *Echinosphærites aurantinum* Gyllenh.

Orthoceras limestone

(d) Upper gray or Chiron limestone
(c) Upper red limestone
(b) Lower gray or Asaphus limestone } Upper Llandeilan
.....*Hiatus and disconformity*.....

(a) Lower red or Limbata limestone
Lower Didymograptus shale
Planilimbata limestone } Lower Arenigian
.....*Hiatus?* .....

Cambrian

Formerly the name of "Orthoceras limestone" was applied to a limestone series included within the graptolite-bearing shales of the Ordovician and since the Lower Didymograptus shale (Phyllograptus shale) is early Arenig, the Orthoceras limestone was also referred to the Arenig. Since there is a hiatus existing between the Lower gray or Asaphus limestone and the Lower red or Limbata limestone, the latter is now united (when the Lower Didymograptus shales are absent) with the Planilimbata limestone, the combined series being called "Megalaspis limestone". The name "Orthoceras limestone" is now restricted to the 3 limestones overlying the hiatus, namely the Lower gray limestone, the Upper red limestone and the Upper gray limestone, and these represent the later Llandeilan or late Middle Ordovician age. From the "List of the Fossil Faunas of Sweden" we find that the species *Vaginoceras* (*End.*) *wahlenbergi* Foord, *Vaginoceras* (*End.*) *vaginatum* Schloth, and some other forms were actually found in the Lower gray Orthoceratite Limestone,[1] in other words they occur in the same horizon as in China. Foord's statement, of course is not correct.

1. G. Lindström: List of the Fossil Faunas of Sweden, I., pp. 9-10.

DESCRIPTION OF SPECIES

Class **CEPHALOPODA**

Order **NAUTILOIDEA** Zittel

Suborder **Holochoanites** Hyatt

Family **ENDOCERATIDAE** Hyatt

Genus **CAMEROCERAS** Conrad (emend. Hyatt)

Cameroceras cf. styliforme Grabau

Plate I., Figs. 1-3

1922. *Cameroceras styliforme* Grabau: Ordovician Fossils from North China, p. 39, pl. IV, figs. 4-6.

There are a number of black, slender and cylindrical structures adhering to the weathered surfaces of dark gray limestone fragments, collected from western Hupeh by Mr. Hsieh. The exterior of the material has been so deeply eroded that one cannot distinguish in the field what types are represented. After separating it from the rock and slicing it into sections it becomes apparent that we are dealing with the endoconch of *Cameroceras*, or of *Proterocameroceras*. These structures are represented only by fragments. One of them (Plate I., Fig. 2) measures about 40 mm. in length. Its cross section is slightly oval, being 11.5 mm. in transverse, and 10 mm. in dorso-ventral diameter at the upper end. The ventral side is slightly flattened. The endoconch is provided with an endotheca, which has been partly preserved through protection from weathering by the country rock. The endotheca is rather thin, and its surface is clearly marked by the ectoseptal edges, which are oblique to the ventral side forming with it an angle of about 50°. Owing to the fact that the specimen is much eroded, the character of the ectoseptal annulations on the ventral side is entirely unknown, therefore the position of the endoconch is rather uncertain. The ectoseptal distances, as shown by these edges on the lateral side, are very uniform, reaching 2 mm. more or less. In the interior of the endoconch there are some endosepta. The spaces between them are wholly filled with the white crystalline deposit, but the endocone is empty, and assumes a semi-lunar section with a flat base, corresponding to the ventral side of the endoconch. In another

specimen (Plate I., Fig. 3) the apical angle of the endosepta shown in the longitudinal section is about 25°. Endosiphuncle not observed.

REMARKS: The apical portion of the endoconch has not been preserved in the specimen now at hand, so its generic identification (either as *Cameroceras* or *Protero-cameroceras*) is not quite certain. According to its shorter length and other respects it may be compared with Grabau's species[1] collected from the Liangchiashan limestone of Liang-chia-shan near Ching-wang-tao, eastern Chihli.

HORIZON AND LOCALITY: From the upper part of Ichang limestone at Lo-jo-ping of I-chang-hsien (Coll. C. Y. Hsieh)

Cameroceras tenuiseptum Hall var. **ellipticum** Yü (var. nov.)

Plate II., Figs. 1 and 2.

1847. *Orthoceras tenuiseptum*, Hall: Palaeontology of New York, Vol. 1, p. 35, pl. VII, fig. 6.
1902. *Orthoceras tenuiseptum*, Raymond: Am. Pal. Bul. Vol. I, No. 14, p. 19.
1906. *Cameroceras tenuiseptum*, Ruedemann: New York State Museum. Bul. 90, p. 408, pl. 3, figs. 1,2; pl. 4, fig. 1; pl. 5, figs. 5, 6; pl. 6, fig. 2.

This form is only represented by fragments of the internal mold. Neither the apical end nor the larger extremity is preserved. It had suffered so deeply from weathering that the outer layer of the mold has turned into a very soft yellowish substance. The ectoconch is robust and cylindrical in form. It is elliptical in cross section, the ratio between the two diameters being 4:3. It tapers gently at the rate of nearly 1:13.

The ectoseptal distances are very closely arranged, varying from 4-5 mm., while the longer diameter of the ectoconch measures 43-50 mm. Roughly speaking the ectosepta are distant about one tenth the longer diameter. The depth of the ectosepta is very high, equalling that of three cameræ. The ectoseptal sutures are slightly undulating. The ectoseptal chambers are more or less free from the organic deposit except a few of them, in which the stereoplasmic deposit extends from the margin of the shell toward the interior and stops at some distance from the endoconch.

The endoconch is situated in close juxtaposition to the outer shell. Its cross section too is elliptical. The endosepta have not been observed. The empty endocy-

1. loc. cit.

linder is very large and its major diameter is practically equivalent to 1/2 that of the ectoconch. In a favourable light the endotheca may be clearly seen along the inner side of the invaginated tubi.

COMPARISON: So far as we know, the form, which bears the closest resemblance to this specimen, is *Cameroceras tenuiseptum* Hall. The transverse sections of the ectoconch and the endoconch of Hall's species are circular, but those of the present form are both elliptical. Moreover, the ectosepta of the latter are comparatively more widely separated than are those of the former.

HORIZON AND LOCALITY: This variety was obtained by J. L. Smith and C. Y. Hsieh respectively from the upper part of Neichiashan formation at Nei-chia-shan near Sin-tan, Tze-kuei-hsien.

Cameroceras hsiehi Yü (sp. nov.)

Plate I., Figs. 42-b.

Shell straight, slender, gradually tapering at the rate of 1 in 10. The cross section of the ectoconch is elliptical, having its two diameters at the ratio of 11:9. Neither extremity preserved. The septate fragment measures little less than 80 mm. in length.

The interspaces between the ectosepta are rather short, being about from 1/6 to 1/5 the longer diameter of the ectoconch. They are 3.5 mm. distant from each other in the lower preserved end and 6 mm. in the upper, while the corresponding longer diameters of the ectoconch are 22 mm. and 30 mm. respectively. The ectosepta are very deep, with a concavity equal to the depth of one and one half cameræ. The tubi have a length of more than one camera.

The endoconch is large, about one third the longer diameter. Under the magnifier we can clearly see that along the inner sides of the tubi the endotheca characteristic of the genus *Cameroceras* is present. The endoconch is perfectly circular in outline. Its position is in contact with the ectoconch. Only the last endoseptum is exposed, and the space below it is wholly filled with calcite. The sides of the endocone seem to be undulating.

In the empty cameræ there is a slight and irregular organic lime-filling deposited along the margins of some ectosepta. Test not preserved.

COMPARISON: This species agrees in some respects with *Cameroceras brainerdi* Whitfield[1] from the Fort Cassin beds along the shore of Lake Champlain, but our shell has an endoconch of circular section and the rate of tapering is much more rapid. Another one nearer to this is *Cameroceras tenuiseptum* Hall[2], but the present form differs from it in having an elliptical shell section, a smaller endoconch and the relatively more separated ectoseptal distances. From the preceding variety of that species the present shell differs in having the circular and smaller endoconch.

HORIZON AND LOCALITY: Only one specimen was obtained from the upper Neichiashan formation near Sin-tan by Mr. Hsieh, in whose honour the specific name is given.

Cameroceras subtile Yü (sp. nov.)

Plate I., Figs. 5 a-b.

This species is known only from a fragmentary phragmacone, which is straight and cylindrical in external form. Both the cross sections of the ectoconch and the endoconch are elliptical. The two diameters of the ectoconch have the proportion of 3 : 2. This fragment reaches a length of a little less than 60 mm. The rate of growth may be computed as 1:10 approximately.

The ectosepta are distant almost uniformly, being about 5 mm., while the ectoconch measures 28 mm. in longer diameter at the lower preserved end and 31 mm. at the upper. The ectoseptal sutures are flexuous with a strong concavity exceeding the depth of one camera. The latter are filled with yellowish red matrix. The ectosepta are lined by a thin layer of the organic stereoplasm about one half millimeter in thickness. The tubi are visible, extending a short distance beyond the preceding septum.

The endoconch is provided with an endotheca, which is clearly shown even to the naked eye. It attains a maximum width of about 1/3 that of the outer shell. It is subcentral in position but does not contain the endosepta in this fragment. The ectotheca has been completely weathered away and the surface of the internal mold only shows the undulating ectoseptal edges.

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1. Ruedemann: Cephalopoda of the Beekmantown and Chazy formation of the Champlain Basin, p. 405, pl. 1, figs. 5, 6; pl. II, fig. 1.

2. loc. cit,

COMPARISON: This species somewhat approaches to *Cameroceras brainerdi* Whitfield[1] in some respects, but the former has the tapering more rapid and the endoconch not marginal as in the latter form. It may also be compared with *Cameroceras hsiehi*, but differs from it in having the subcentral and elliptical endoconch.

HORIZON AND LOCALITY: This form was obtained from the same horizon as the preceding species near Sin-tan. (C. Y. Hsieh Coll.)

Cameroceras sp.

Plate II., Fig. 3.

This form is too fragmentary for specific determination. The septal portion preserved only contains four cameræ, and has a length of 45 mm. Owing to the fact that the specimen is much eroded, the cross section of the ectoconch and the rate of tapering can not be determined.

Ectosepta gently concave, having a depth of nearly 2/3 that of the camera. The ectoseptal interspaces increase very slightly in distance, being nearly equal to 2/5 the diameter of the outer shell. The septate chambers are wholly empty. The organic stereoplasmic deposit occurs only along the interior sides of some cameræ.

The endoconch is marginal. Since it has also been greatly rubbed, neither the transverse section nor the size of the inner shell may be determined with any certainty. Nevertheless, from what remains we can tell that it is confined externally by the presence of an endotheca and filled internally with the calcite deposit. The tubi extend apically in an irregular manner and the endotheca also assumes the wavy appearance, following the direction of the tubi.

Undoubtedly the present specimen belongs to the genus *Cameroceras* in having the characteristic endotheca. But its other important properties are too little known, hence its specific determination is impossible.

HORIZON AND LOCALITY: Upper part of Neichiashan formation near Sin-tan.

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1. Ruedemann: Cephalopoda of the Beekmantown and Chazy Formations of the Champlain Basin. p. 405, pl. I, figs. 5,6; pl. 2, fig. 1.

Genus ENDOCERAS Hall

Endoceras teoi Yü (sp. nov.)

Plate I., Figs. 6, 7a-b.

Ectoconch straight, cylindrical. Form of cross section unknown. Endoconch elliptical, of considerable size and filled with conical endosepta. Ectosepta crowded. Tapering of ectoconch very gentle. Endotheca absent.

This specimen is represented only by a portion of the ectoconch exposed on the surface of a polished slab. Its actual length is unknown. The width at the lower end of the preserved fragmentary part is 30.5 mm. At a point about 81 mm. from the lower end it has a breadth of 36.5 mm. This gives the rate of tapering about 1 mm. in a length of 13.5 mm.

The ectosepta are very numerous and strongly concave, with a concavity about one and a half times their distance apart at the center. The interspaces between them are nearly equal, averaging about 6.5 mm. apart. The ectosepta are provided with long tubi, which distinctly show that they extend from the ectoseptum where they originate to a distance of one camera toward the apex.

The endoconch is situated excentrically. Its size is remarkably large, having a maximum width of $^2/_3$ that of the ectoconch or more. The interior of the endoconch is occupied by endosepta tapering off at the center into a narrow endosiphuncle. From the cross section at the lower preserved end we find that the endosiphuncle is oval in outline, measuring 0.7 mm. and 0.9 mm. in the shorter and the longer diameter respectively. At the same stage the corresponding longer diameter of the endoconch is 14 mm. The endoconch bounded by the last endoseptum has a subtriangular section with an apical angle of 20°.

Both the cameræ of the ectoconch and the endoconch are filled with the red lime matrix, in which the shell of this specimen is embedded. Many of the ectosepta, however, show a slight stereoplasmic thickening on their upper, and more rarely on their under side as well.

There is another specimen (Plate I., Fig. 7.) probably of the same species. The endoconch attains a length of nearly 160 mm. The space below the final endoseptum of the endoconch has been wholly converted into the crystalline deposit, but the terminal endocone is empty. The ectoconch is partly crushed, preserving however ectosepta around the upper part of the endoconch. At the lower extremity a very

small section of the endosiphuncle may be seen in the central part of the endoconch, being about 0.3 mm. in diameter and filled up with the red lime matrix. In the same place the endoconch is sub-elliptical in section, measuring 9 mm. in its major diameter, and 7 mm. in minor. The apical angle of the final endoseptum is nearly the same as that in the preceding specimen. The cameræ of the ectoconch are entirely free from any deposit except the ectosepta, which are also slightly thickened as in the preceding specimen.

COMPARISON: This species bears a close resemblance to *Endoceras* (*Cyclendoceras*) *annulatum* Hall[1] from the Trenton limestone at Watertown New York. But Hall's form has the ectosepta more approximate as compared with the diameter of its ectoconch. Moreover, the annulated ectotheca is not recognized with certainty in the present species, though there seems to be an indication of it in the undulating profile along the sides of the ectoconch in the polished longitudinal section.

HORIZON AND LOCALITIES: One specimen (Plate I., Fig. 6.) was collected from the red thin-bedded limestone of the upper division of Middle Ordovician age at San-shan-yuan (三山原) and the other (Plate I., Fig. 7.) from the same horizon at He-chiao (黑橋), Chung-yang-hsien. The specific name is given in honor of Professor J. S. Lee. (Coll. C. Li and W. P. Shu)

Endoceras grabaui Yü (sp. nov.)

Plate II., Fig. 4.

General form cylindrico-conical, more or less elongate, slightly arcuate, gradually diminishing toward the apex, and elliptical in cross section; endoconch very broad, enclosed by the continuous tubi, not forming a straight tube but giving the sides of the endoconch the appearance of an irregular undulation.

The ectoseptal intervals are slightly variable in their distance apart from one another, ranging from 9 to 11 mm. throughout the whole length of the fragment. The ectosepta are thin and very deeply concave, having a convexity of more than one septal distance. The ectoseptal tubi are continuous, but extend across the different ectoseptal spaces in different ways. Thus some of them are bent inwards; some nearly straight and slightly oblique toward the interior; and finally some tubi turn inwards at first and gradually backward as well as outwards.

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1. J. Hall: Palæontology of New York, Vol. I, p. 207, pl. XLIV, figs. 1 a, b.

The endoconch is elliptical in transverse section, occupying the central position of the ectoconch in the preserved part of the specimen. It is readily seen that the interior of the endoconch is occupied by an endoseptum in the upper part of the preserved fragment and another one at the lower. The apical angle formed by these conical endosepta are nearly the same, or about 10°. The wall formed by the continuous tubi appears to have a zigzag outline in section and the width of the endoconch, as exposed in the longitudinal section, varies from 7 mm. to 15 mm. narrowing in one place and broadening in another.

Neither the larger nor the smaller extremity has been observed. The fragment measures more than one hundred and thirty millimeters in length. The longer diameter at the upper end of the shell is 45 mm., gradually contracting toward the smaller end which is 25 mm. in diameter. This gives the rate of tapering 1 in 6.5

Ectotheca thin, but its surface characters unknown. No trace of any deposit is found within the ectoconch or the endoconch.

COMPARISON: This species is somewhat allied to *Endoceras magniventrum* Hall [1] from the higher part of the Trenton limestone of New York State in the characters of the close, strongly concave ectosepta and the undulating wall of siphonal tubi, but differs from the latter in the slightly curved ectoconch, much narrower endoconch, and more rapid tapering of the outer shell. The same characters are also used for distinguishing it from the preceding species.

HORIZON AND LOCALITY: From the argillaceous limestone bed of the Neichiashan formation at the small hill named Shih-lung-sze (石龍寺) about 10 li to the west of Wang-chia-chi (王家集), I-cheng-hsien. This species is named in honour of Professor A. W. Grabau, Chief Palæontogist to the Geological Survey. (Coll. W. P. Shu and C. C. Yü)

Genus **VAGINOCERAS** Hyatt

Vaginoceras (Endoceras) wahlenbergi Foord.

Plate III., Figs. 1a—b.

1888. *Endoceras Wahlenbergi*, Foord: Catalogue of Fossil Cephalopoda, part I, p. 136, Text figs. 11, 13, 14.

1895. *Endoceras Wahlenbergi*, Holm: Geol. Foren. Förh. i Stockholm, Bd. 17 Heft 6.

1917. *Endoceras Wahlenbergi*, Reed: Palæontologia Indica, New Series, Vol. VI, Mem. No. 3, p. 30, pl. V, fig. 11.

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1. J. Hall: Palæontology of New, York, Vol. I, p. 218, pl. LIII, figs. 1 a-e.

Shell large, somewhat slowly enlarging, with a large endoconch inside. It attains a size of 305 mm. preserving a part of the living chamber. Apical extremity unknown. Transverse section circular. Its rate of growth is computed about 1 in 11.5. Character of surface not observed.

The ectosepta are gently concave, their convexity being about two thirds the depth of the camera of the ectoconch or a little more. The distance between the ectosepta varies in an irregular manner. It measures 11 mm. at a point about 90 mm. from the apex, where the diameter of the ectoconch is 31 mm; and 16 mm., where the diameter is 40 mm. When the ectoconch increases its diameter to 50 mm., the ectoseptal distance is suddenly reduced to 13 mm. Nevertheless, the ectoseptal distances continue on the whole to increase upwards until close to the living chamber, where it retains the distance characteristic of the earlier stage (Five camerae are contained in the space of 65 mm. including the last camera).

The endoconch is very large, marginal and circular in cross section. It is continued upwards in a large endocylinder, which is empty and has a diameter of 12 mm, where the ectoconch measures 33 mm. in diameter, this being about one third that of the ectoconch. The organic stereoplasmic lining is clearly seen along the margins of the ectosepta. The camerae are partly filled up with the crystalline deposit, but the upper-most ones close to the living chamber are entirely empty. Near the apical portion of the preserved part of the shell the final conical endoseptum (endocone) is shown. It has an apical angle of 10°. The rest of the endoconch has been converted into crystalline calcite with much mixing of black material. The invaginated tubi bend inwards, and then slightly outwards. When they reach the geniculations of the preceding ectosepta, they turn again inwards and backwards.

Comparison: Hyatt proposed the generic name *Vaginoceras* for the form which differs from *Endoceras* proper in having the longer invaginated tubi and more numerous endosepta[1]. From the text figure of *Endoceras wahlenbergi* Foord[2] we find

1. G. T. Troedsson considered, after the suggestion made by Foerste, the number of endosepta as the only distinguishing character between the *Endoceras* and *Vaginoceras*. (See Troedsson: On the Middle and Upper Ordovician Faunas of northern Greenland, p. 24). Of course, the length of the tubi can not be correlated with the number of the endosepta as Hyatt assumed. But in this paper the length of the tubi is taken as the distinguishing feature rather than the number of the endosepta. The reasons are: (1) The number of endosepta is sometimes unreliable, for they may not be wholly preserved. (2) The spaces between the endosepta are often completely filled with the crystalline calcite and the endosepta are not distinctly enough shown to determine their number. (3) In many forms the endoconch as well as endosepta, limited to the apical portion of the ectoconch, are often not preserved; and the empty, long endocylinder only remains. So far the length of the tubi is always clearly exposed, no matter whether the specimen is well preserved or very framentary. Therefore, the length of the tubi is chosen here as the important factor for distinguishing these two genera.

2. loc. cit.

that the long tubi extend beyond the space of one camera. According to the statement of Hyatt the generic name of Foord's species should be changed into *Vaginoceras*. As to the specific identification, the characteristics of our specimen strongly resemble Foord's species, but the ectosepta become more crowded in the adult stage, which is not the case in Foord's form. Nevertheless, this feature may be considered as a minor point due to senility, and can not serve to characterize a distinct species.

HORIZON AND LOCALITY: Collected from the upper part of Neichiashan formation at the northern side of Tai-hung-shan (太紅山) about one mile or more to the west of the city of Nan-chang-hsien. According to Foord's description *Vaginoceras wahlenbergi* belongs to Arenig in Sweden, Norway, Russia and other localities in Europe, but this is incorrect, the horizon being late Middle Ordovician[1]. (W. P. Shu and C. C. Yü Coll.)

Vaginoceras wahlenbergi Foord var. cylindrica Yü (var. nov.)

Plate IV., Figs. 1, 2a-b.

Ectoconch robust, cylindrical. Endoconch large, situated nearly close to the margin of the outer shell. This variety is represented so far only by a fragment belonging to the upper part. The cross section of the endoconch is circular, but that of the ectoconch is quite obscure, though it is probably circular too. Rate of increase about 1 in 12.6.

Ectosepta moderately concave with their depth scarcely exceeding two thirds of the camera. The ectoseptal intervals become gradually and slightly longer in distance apart as the ectoconch advances in age, measuring 15 mm. apart near the lower end and 17 mm. near the upper, or about two fifth the diameter of the outer shell.

The endoconch is prolonged into a nearly cylindrical endocylinder. Its diameter is a little less than one third as wide as that of the ectoconch. In the actual measurement the diameter of the ectoconch attains 40 mm. at the lower end, whereas the corresponding diameter of the endoconch is 12.5. The invaginated tubi are distinctly visible. No endoseptum has been found, the endoconch proper not being preserved. Stereoplasmic deposit often occurs on the margins of the ectosepta, this being about 1 mm. thick.

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1. See stratigraphic part, pp. 20, 21.

Another individual (Plate IV., Fig. 2) is also known from a fragment of more than one hundred and thirty millimeters in length. The cameræ of the ectoconch increase their depth forward at a regular rate, ranging from 9 to 13 mm., where the corresponding diameter of the ectoconch is from 27-35 mm. Endocylinder circular, marginal, large, being about 2/7 the diameter of the ectoconch. Concavity of ectosepta about 2/3 the camera. The outer shell tapers at the rate of 1 in 12.5. The organic stereoplasm deposit is seen on the under side of the ectosepta more commonly than on the upper.

Comparison: This form is closely related to *Vaginoceras wahlenbergi* Foord, from which it may be slightly distinguished by the more regular increase of the ectoseptal distance and the smaller size of the endoconch and endocylinder. According to the diagnosis given by Foord, *Vaginoceras wahlenbergi* has a much larger endoconch, measuring "nearly half the diameter in the young shell" and "about one third the diameter" in the adult. Nevertheless, the other important characters of our shell are very similar to those of Foord's species, it is, therefore, preferable to refer it to a variety of *Vaginoceras wahlenbergi*.

Horizon and Localities: One specimen (Plate IV., Fig. 2) was found just below the thin-bedded red limestone in the vicinity of Liu-chia-sze south of Cha-ti-pu, Hsien-ning-hsien, and another specimen (Plate IV., Fig. 1.) was from the same formation near He-chiao, Chung-yang-hsien. (C. Li and W. P. Shu Coll.)

Vaginoceras endocylindricum Yü (sp. nov.)

Plate II., Figs. 5a-c; Plate III., Figs. 2a-d, 3a-b.

This specimen (Pl. III., Figs. 2a-d) is known by a large orthocone which attains a length of 280 mm. with a slender obtuse termination at the apical end. The section of the ectoconch is circular. Its diameter measures 42.5 mm. at the larger end, and 145 mm. at the smaller. It tapers at the rate of 1:9.8. Owing to the imperfection of the upper end of the specimen the original size of the living chamber has not been fully determined. Nevertheless, the length of its remaining part is more than twice the diameter of its base.

The ectosepta are rather closely set. Their convexity attains nearly the depth of one camera. The ectosepta are 5 mm. apart near the apical end and increase regularly slightly forward. There are three cameræ in the space of 20 mm. in the mature part of the phragmacone, where the ectoconch has a diameter of about 23 mm. Near the living chamber, the ectoseptal interspace is 9 mm. at the diameter of 35 mm.

The endoconch is not very large and situated in close juxtaposition to the flat ventral side of the outer shell. It is circular in cross section, its diameter being 6 mm. where the diameter of the ectoconch is about 26 mm. The continuation of the tubi is beyond the next preceding ectoseptum. The endosepta are confined to the apical end with a very small endosiphuncle exposed in the middle part of the endoconch. The endocylinder and endocone are empty, but all the cameræ are completely occupied by the crystalline calcite of secondary origin interspersed with some black material.

Another piece (Pl. III., Fig. 3) probably of the same species represents a fragment of the posterior part. Cross section circular. Ectosepta crowded. At the smaller fragmentary end the ectotheca and ectosepta are detached and only the endoconch projects out. Ectosepta moderately concave. Ectoseptal distance about 4.5 mm. at the diameter of 18 mm. As the longitudinal section is normal to the dorso-ventral diameter, the endoconch at first sight seems to occupy a central position in the ectoconch, but in reality it is probably marginal to the outer shell. The ectoconch has a diameter of 16 mm. at the lower end, where the corresponding diameter of the endoconch is 4.5 mm. The endoconch and endocylinder are not preserved in the upper portion of the specimen because of the direction of the section.

There is a third specimen (Pl. II., Fig. 5.) which was procured from the Tafang limestone at Yang-sing-hsien. The apical portion is not preserved. The ectoseptal distances are less than 1/3 the diameter of the outer shell. The endoconch is circular, marginal and equal to 1/4 the diameter of the ectoconch. This specimen is similar to the preceding ones in all respects except the rate of tapering, which appears to be more rapid, measuring 1 in 16. The test is partly preserved. It consists of two layers. The interior layer is much thinner and covered by the very fine transverse striæ. The outer one is quite obscure, though it is probably smooth.

Comparison: This species is characterized by its fairly closely set ectosepta, relatively smaller endoconch and long empty endocylinder with the endosepta limited to the apical portion. It agrees in some aspects with *Vaginoceras wahlenbergi* Foord,[1] but is distinguished from the latter by its smaller endoconch and more approximate ectoseptal distance. From the description of *Endoceras reinhardi*? Boll[2] including *Orthoceras commune* Angelin-Lindström and some others, we find that the present species may be compared with Boll's form, but differs in having the shorter interspaces between the ectosepta, which are nearly half the diameter of the outer shell in Boll's species. Moreover, our shell has shown the considerably long tubi indicating a *Vaginoceras*, but those in Boll's form have not been characterized in the description.

1. loc. cit.
2. Foord: Catalogue of Fossil Cephalopoda, Pt. I, p. 145.

HORIZON AND LOCALITIES: The first two specimens (Pl. III,, Figs. 2 and 3) were collected by C. Li and W. P. Shu from the beds just below the red limestone near Ta-wu-shu, north of the western end of Pei-yang-shan (白羊山), Chung-yang-hsien. The last one (Pl. II., Fig. 5) was collected by Mr. C. Y. Hsieh from the uppermost purple calcarcous shale of the Tafang limestone at Ta-fang village in the Yang-sing-district.

Vaginoceras peiyangense Yü (sp. nov.)

Plate V., Figs. 1a-b, 2a-b.

This orthocone is fairly slender, elongate, reaching a length of 425 mm. The ectoconch terminates in an extremely acute point. It enlarges in diameter very slowly in the young part, but rapidly toward the apertural portion. The diameter of the ectoconch increases from 15 mm. at the lower part to 30 mm. at the upper, the distance being 289 mm. This gives a rate of expansion of 1 mm. in 19 mm. The remaining part of the living chamber is rather long, having a length of 60 mm. and a diameter of about 30 mm. at its base. Aperture not observed. The section of the outer shell is ovately elliptical with a moderately large endoconch close to the margin of the shell.

The ectosepta are very thin and gently concave. Their depth is about one half that of a camera. The ectoseptal interspaces or camerae regularly increase in height toward the aperture, there being three camerae in the space of 20 mm. at the apical portion and one camera or a little more in the same space at the stage next to the body chamber.

The endoconch is tubular, moderately large with an oval section. It measures 6 mm. in major diameter and 4.5 mm. in minor. In the same stage the transverse diameter of the ectoconch is 26 mm. It lies rather close to the outer shell, if it is not absolutely in contact with the latter. It is comparatively flatter on the ventral side. At a point 150 mm. from the apex, we find in section that the subtriangular endocone exists within the endoconch having an apical angle of nearly 17°. The endoconch of the earlier stage is solidly filled with the calcite deposit, leaving the endosiphotube open in the middle. Its diameter is more than 0.1 mm. and is plainly visible even to the naked eye. The endoconch is provided with the tubi, which continue apicad beyond the next preceding ectoseptum for a short distance further.

In another specimen (Pl. V., Fig. 2) the camerae of the ectoconch are relatively shallower. The ectosepta regularly and slowly increase their distance upwards, varying from 5 mm. to 7 mm., where the corresponding width of the ectoconch is from 13-18 mm.

The endoconch is of large size, ovately elliptical in section, and nearly marginal to the outer shell (being 0.7 mm. distant from the ventral side). It measures 8 mm. in the longer diameter and 6 mm. in the shorter at the upper end of the fragment, where the actual diameter of the ectoconch can not be determined, but the ectoseptal distance is about 7 mm. This fragment is 123 mm. in length. At the lower part of the specimen, the ectotheca as well as the ectosepta have been crushed, and the endoconch remains protruding with some invaginated tubi preserved on its sides. Rate of increase 1:17.

In both of the specimens the cameræ are lined with the organic stereoplasm in moderate thickness, but some are perfectly empty. Test unknown.

Comparison: In its general form, this species may be compared with *Endoceras distans* Hall[1]. But our shell has a much smaller endoconch and an ovately elliptical section of the ectoconch, which is quite different from that of Hall's species. It is also distinguished from *Vaginoceras wahlenbergi* and *Vaginoceras endocylindricum* by its more distant ectosepta, ovately elliptical section of endoconch and less rapid tapering of the ectoconch.

Horizon and Localities: One specimen (Pl. V., Fig. 1) was obtained from the bed just above the massive blue limestone at the western end of Pei-yang-shan, and the other (Pl. V., Fig. 2) from the same horizon at He-chiao, Chung-yang-hsien. (Coll. C. Li and W. P. Shu.)

Vaginoceras (Endoceras) belemnitiforme Holm

Plate 1., Fig. 8

1885. *Endoceras belemnitiforme* Holm: Palæontologische Abhandlungen, Bd. III, Heft I, p. 5, Taf. I, figs. 1-5.

Shell cylindrical, straight, embedded in the upper red Tafang limestone and without any trace of the test remaining. It tapers at the rate of about 1 in 10. The apical portion has not been observed, and the larger extremity is also incomplete. The ectoconch is subcircular (probably by compression) in transverse section with an endoconch lying at its margin.

The ectosepta are widely separated from each other, the distance equalling nearly half the diameter of the outer shell. In actual measurement it reaches 12 mm. at the diameter of 24 mm. When the ectoconch enlarges to 26 mm. in diameter, it is reduced to 10 mm. After that it assumes the original length again. Though the distances between septa vary slightly, on the whole they are fairly constant

1. Hall: Palæontology of New York, Vol. I, p. 220, pl. LVIII, figs. 1 a,b.

The interior of the cameræ are deprived of any deposit except the margins of the ectosepta, on which the stereoplasm is slightly and irregularly deposited. Ectosepta very thin, having a concavity a little less than one camera.

The endoconch is in contact with the outer shell. It is cylindrical in longitudinal section and circular in transverse. It appears to remain about 10 mm. in diameter throughout the whole length of the fragment preserved, so that it occupies nearly 1/2 the diameter of the ectoconch at the lower fragmentary end and 2/5 at the upper. No endosepta are seen. The endotheca is absent and the inner shell is confined by the continuation of the imbricating tubi, which in this specimen seem not so long as those in the form figured by Holm.

REMARKS. This species is characterized by its remote and almost equal ectoseptal distances, and cylindrical and large endoconch. Even though we know nothing about the apical end of our shell, no form comes nearest to the present specimen other than *Vaginoceras belemniforme* Holm from the upper red Orthoceras Limestone on the island of Oeland.

HORIZON AND LOCALITY: From the red limestone bed of middle Ordovician age in the upper part of the Tafang limestone near Ta-fang village, Yang-sing-hsien. The specimen was collected by Mr. C. Y. Hsieh.

Vaginoceras shui Yü (sp. nov.)

Plate IV., Figs. 3a-b.

Ectoconch of unknown size, slender, subcylindrico-conical. Cross section circular. Endoconch moderately large, submarginal. Both the apical end and the basal extremity unknown.

Ectosepta remarkably gently concave, about one third as deep as the cameræ. The ectoseptal distances slightly increase from 6 mm. at the lower preserved end to 8 mm. at the upper, while the corresponding width of the ectoconch are 14 mm. and 19 mm. respectively (The real diameter of the ectoconch would be greater than this, because the section is not in the median plane).

The endoconch is circular? and situated near the margin of the ectoconch. Its diameter is little less than one third that of the outer shell. It is completely surrounded by cameræ and distinctly marked by the tubi By the aid of a lens we can see the tubi are so long that they overlap backward beyond the preceding ectoseptum extending even to the third one. Inside the endoconch a concial funnel-shaped endoseptum is included with the deposit of crystalline lime below.

The diameter of the ectoconch measures 13 mm. at the smaller extremity of the fragment and 22 mm. at the larger. The distance between them is 108 mm. It tapers at the rate of about 1 in 12.

COMPARISON: This species appears to be related to *Vaginoceras belemnitiformis* Holm[1] in the extremely long tubi, but the former differs from the latter in having the comparatively narrower endoconch and shorter ectoseptal distance. Moreover, the ectosepta of our specimen become increasingly distant with the growth of the ectoconch,which is not the case in Holm's form. It is also distinguished from any of the foregoing species by its strikingly long tubi.

HORIZON AND LOCALITY: In the bed above, but not far from, the thick-bedded blue limestone near Wang-chia-sze, Chung-yang-hsien. The specific name is given in honour of Mr. Shu, by whom this species was collected.

Vaginoceras chiontzekouense Yü (sp. nov.)

Plate V., Fig. 3.

Ectoconch straight, cylindrical, rather slowly enlarging at the rate of 1:12. Transverse section elliptical? Endoconch not very large, lying in contact with the outer shell.

This fragment reaches a length of more than 74 mm. Ectosepta moderately concave, having a depth of more than one half of a camera. The ectoseptal interspaces increase regularly and very slowly in length as they approach the basal extremity, ranging from 12 to 16 mm., where the corresponding diameters of the ectoconch are 32 and 38 mm. respectively.

The endocylinder only is shown. It is elliptical in section. From the longitudinal section we may see that the interior of the endocylinder does not reveal anything but the black lime matrix. The tubi are not well preserved, but from a few that remain it seems that the succeeding tubus is inserted into the next preceding one. The diameters of the endocylinder have a ratio of 8:5. Its longer diameter is nearly 1/4 that of the ectoconch. None of the organic stereoplasm exists in the cameræ except the deposit of secondary origin.

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1. G. Holm: Palæontologische Abhandlungen, Bd. III, Heft 1, p. 5, Taf. I, figs. 1-5.

COMPARISON: At the first glance this species appears to show no difference from *Vaginoceras wahlenbergi* Foord var. *cylindrica*, but on careful examination its elliptical section and narrower size of the endocylinder as well as the absence of stereoplamic deposit on the ectosepta give it a distinctive appearance.

HORIZON AND LOCALITY: From the argillaceous limestone of Neichiashan formation at Chien-tze-kou (剪子溝), Nan-chang-hsien. (Coll. W. P. Shu and C. C. Yü.)

Vaginoceras neichianense Yü (sp. nov.)

Plate I., Figs. 9a-b; Plate II., Figs. 6a-b, 7a-b.

General form subcylindrical, cross section elliptical, ectosepta crowded, endoconch large, subcentral and circular in section.

This is a fragmentary specimen preserving the septate portion. It is about 100 mm. in length. No external character is perceptible except the regular, transverse ectoseptal edges exposed on the eroded surface of the cast. Rate of increase 1 in 8.5 approximately. The two diameters of the extoconch are roughly at the proportion of 4:3.

The ectosepta are closely set. The interspace between them slightly increases upward, being equivalent to 1/5 the longer diameter of the ectoconch at the lower part of the fragment and 1/6 at the upper. The concavity of the ectosepta is a little more than the distance of one camera at its center.

The endoconch is rather large, its diameter being nearly equal to 2/5 the longer diameter of the ectoconch. It is situated a short distance from the center of the conch. The continuous tubi extend apically to the point about one fourth the depth of the next preceding camera, or a little more. The ectosepta are gently bent backward before reaching the endoconch. The interior of the endoconch below the last endoseptum has been changed into a white crystalline deposit. The endocone shows a slightly elliptical outline in transverse section. Some cameræ are filled with the calcite deposit, and some ectosepta are also thickened by the stereoplasm to a very small amount.

There are numerous specimens belonging to the same species, though they are slightly different from one another. One specimen (Pl. II., Fig. 6) collected from Chung-yang-hsien reaches a length of about 31 mm. It consists of four cameræ embedded in the red limestone. It tapers more rapidly, about 1:6. The endoconch is relatively narrower, attaining a size of 1/3 the longer diameter of the ectoconch. Ectosepta distant about $^1/_4$ the major diameter.

Another one (Pl. II., Fig. 7) expands its shell more slowly, the rate being 1:10. The empty endocylinder is only preserved, indicating this fragment nearer the apertural end. Seven cameræ are present. The ectosepta are slightly lined by the stereoplasm. The size of the endocylinder and the ectoseptal intervals are similar to those in the preceding specimen (Pl. I., Fig. 9).

COMPARISON: In some respects this species is quite close to the *Endoceras proteiforme* Hall [1] from the Trenton formation of New York State, but our shell shows the invaginated tubi, which is not a character given in the description by Hall. According to Clarke's statment the tubi of *Endoceras proteiforme* are short. Foerste says: "Apparently they are only a single camera in length". But its diagrammatic sections figured by Hyatt[2] and Troedsson[3] indicate that the tubi are longer than the length of a camera. Even though the latter is the case in Hall's type, the present species may be distinguished from it in having the ectoconch elliptical and the endoconch subcentral and circular. In *Endoceras proteiforme* the ectoconch is circular and the endoconch is marginal and elliptical[4]. It also differs from *Vaginoceras vaginatum* Schlotheim [5] in having the more widely separated ectoseptal interspaces, smaller and subcentral endoconch; and from *Orthoceras* (*Endoceras*) *brongniarti* Troost [6] in having the ectoconch less elliptical, the endoconch comparatively larger, and the ectoseptal distance somewhat longer.

HORIZON AND LOCALITIES: One specimen (Pl. II., Fig. 6) was collected by C. Li and W. P. Shu from the reddish limestone of the Middle Ordovician age at San-shanyuan, Chung-yang-hsien. The rest came from the upper part of the Neichiashan formation near Sin-tan, western Hupeh. (Collected by J. L. Smith and C. Y. Hsieh respectively)

Vaginoceras roedi Yü (sp. nov.)

Plate I., Figs 10 a-c, 11 a-b.

1917. *Cameroceras?* sp. Reed: Ordovician and Silurian fossils from Yunnan, p. 35, pl. VI, figs. 1, 1a.
1920. *Orthoceras?* sp. Yabe and Hayasaka: Palæontology of Southern China, p. 49, pl, XVIII, figs. 3; pl. XXVII, figs. 2 a-c.

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1. J. Hall: Palæontology of New York, Vol. I, p. 208, pl. XLVIII, pl. XLIX, pl. L, pl. LIII, figs. 2, pl. LVII.
2. Zittel-Eastman: Text Book of Palæontology, p. 595, fig. 1105.
3. G. T. Troedsson: On the Middle and Upper Ordovician Faunas of Northern Greenland, I. Cephalopods. p. 27, pl. 8, fig. 4.
4. G. T. Troedsson: On the Middle and Upper Ordovician Faunas of Northern Greenland. I. Cephalopods. p. 27, pl. 7, figs. 1, 2.
5. Foord: Catalogues of Fossil Cephalopoda, Part I, p. 140.
6. Blake: British Fossil Cephalopoda. Part I, p. 162, pl XVII, figs. 1, 1a.

Fig. 1.

Fig. 2.

Fig. 3.

Fig. 1. *Vaginoceras reedi.* External view of a fragment of the ectoconch with a part of the endoconch exposed. Natural size.

Fig. 2. *Vaginoceras reedi.* Longitudinal section of the same, showing the large, empty endoconch and the closely set ectosepta. Natural size.

Fig. 3. *Vaginoceras reedi.* End view of the same. Natural size.

Associated with *Vaginoceras neichianense*, there are many specimens which are represented either by the fragmental phragmacone or the endoconch only. But some of them are known from a part of the septate portion with a large endoconch projecting out of the middle part. The ectoconch is straight, cylindrical and slightly elliptical in cross section. Owing to the fact that the fragment of the ectoconch is very short and not well preserved, the rate of increase can not be determined, nevertheless it appears to be very gentle.

The ectosepta are very closely arranged. The ectoseptal interspace measures 3 or 4 mm. apart, where the ectoconch has a longer diameter of nearly 30 mm. The ectoseptal sutures are slightly undulating. Camerae entirely free from any deposit, and ectosepta strongly concave.

The endoconch is very large, having a diameter of $^1/_2$ that of the ectoconch or more. It is slightly distant from the center. Its cross section is circular. The long tubi are prolonged backwards beyond the next preceding ectoseptum. Neither the deposits nor the endosepta are found inside.

In another fragmental specimen (Pl. I., Fig. 11) of 30 mm. in length the endoconch is larger, measuring 19 mm. in diameter, where the ectoconch has a longer diameter of 35 mm. At the same stage the ectosepta are 3 mm. apart.

Orthoceras sp.[1] described by Yabe and Hayasaka is apparently of the same species. They stated "The specimen is a fragment of a cylindrical shell, in state of internal cast, and 50 mm long; it is oblong in cross section, measuring 29 mm. and 24 mm. in larger and smaller diameter respectively. The surface of the stone nucleus is smooth,

1. loc. cit.

except for 6 sharply impressed annular lines which are 5-7 mm. apart; the impressions are somewhat wavy, probably owing to the secondary deformation of the entire shell. The lines at first sight appear to be the suture lines of the septa, but in reality coincide with them only partially." "The septa are traversed at the center by a broad (12 mm. in diameter) empty tubular space, which is completely shut off from the interior of the camerae by means of the septal necks, these being very long and extending beyond the preceding septum. There is absolutely no organic deposit in the interior of the shell." Even though no such impressed annular lines are seen on the surface of our specimens as is the case in that of the Japanese authors, the large endoconch, long tubi, closely set ectosepta and some other properties show that Yabe and Hayasaka's form is really the same as the present species. Reed had described one specimen from the Ordovician bed of Shih-tien in Yunnan and called it *Cameroceras*.[1] In reality it also belongs to the present species. The original diagnosis given by Reed is as follows.

"The shell appears to have been straight, slightly elliptical in cross section, cylindrical, very slowly tapering. A large undivided body chamber seems to be present, and on it traces of fine concentric lineation are visible, this body chamber measures about 33 mm. in length and has a diameter of about 26 mm. The septate portion of the shell measures just 20 mm. in length and contains 11 septa. The septa, therefore are closely approximate, being rather less than 2 mm. apart; they are thin, horizontal, but very slightly undulated. A transverse section made of the lower end shows that the shell is elliptical with diameters of 21 mm. and 25 mm., and there is a very large siphuncle about 14 mm. in diameter, situated nearer the ventral than the dorsal margin."

COMPARISON: This species is quite similar to the previously described *Vaginoceras naichianense*, but after closely studying it we can see that the present form has the endoconch much larger and the ectosepta much closer. Moreover, the interior of this form is absolutely free from organic deposit, which is present in the other species. It also resembles *Vaginoceras vaginatum* Schlotheim, but may be distinguished from it by the position of the endoconch, which is marginal in Schlotheim's species.

HORIZON AND LOCALITY: From the upper part of Neichiashan formation near Sin-tan. (Coll. J. L. Smith and C.Y. Hsieh respectively)

Vaginoceras uniforme Yü (sp. nov.)

Plate II., Figs. 8a-b, 9; Plate V., Figs. 4a-b.

Outer shell straight, cylindrical, cross section elliptical with a moderately large endoconch submarginal to the ectoconch.

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1. loc. cit.

The ectoseptal distances are nearly uniform, varying from 5-6 mm., or about 1/5 the longer diameter of the ectoconch. Ectosepta with a concavity nearly equal to the depth of one camera.

The endoconch is elliptical in section, being about 9.5 mm. and 8 mm. in its two diameters. At the same section the ectoconch measures 32 mm. in its major diameter. Tapering of endoconch very gentle. The continuous tubi are disposed in an imbricating arrangement. The endosepta are hardly visible in the stereoplasmic filling. The empty cameræ are lined with slight organic deposit, which occurs on the upper side of the ectosepta in the majority of cases.

The ectoconch gradually contracts from the longer diameter of 30 mm. at the upper extremity of the specimen to 23.5 mm. at the lower. The tapering may be roughly estimated to be at the rate of 1 in 11 mm.

Another fragment of this species (Pl. II., Fig. 9) was obtained from the same district. It is of smaller size. The ectosepta are also crowded, distant about 3-4 mm. from one another. The longer diameter of the ectoconch measures 16 mm. at the lower part and 20 mm. at the upper. Concavity of ectosepta about 1 camera. The elliptical endoconch lies submarginal to the outer shell. The stereoplasmic deposit usually occurs above the margins of the ectosepta in very small quantity. Neither the earlier portion nor the apertural end have been observed.

The third one (Pl. V., Fig. 4) was collected from the upper part of the Tafang limestone at Yang-sing-hsien. Its transverse section is also elliptical in outline, the two diameters being at the ratio of 3:2. The ectosepta are uniformly distant from one another, attaining an interval of 6.5 mm. in average, or about 1/4 that of the longer diameter. Endoconch marginal, elliptical, being about 1/3 the diameter of the ectoconch. So far as we know, this specimen is slightly differentiated from the preceding ones in the position of the endoconch, which lies not across the minor diameter but at the quadrant between the longer and shorter diameters.

Comparison: In the position of the endoconch, section of the ectoconch, and the rate of tapering this species may be compared with *Endoceras arctiventrum* Hall[1] from the higher part of the Trenton limestone near Middleville N.Y., but the endoconch of Hall's form is much smaller in size. Our shell has the long invaginated tubi, which are unknown either in the figure or the description of that form given by Hall.

Horizon and Localities: The last named specimen (Pl. V., Fig. 4) collected by C. Y. Hsieh was from the upper red bed of the Tafang limestone at Yang-sing, and the rest from the red limestone at San-shan-yuan, Chung-yang-hsien, (C. Li and W. P. Shu).

1. Hall: Palæontology of New York, Vol. I, p. 217, pl. 51, figs. 2 a,b.

Vaginoceras multiplectoseptatum Yü (sp. nov.)

Plate V., Figs. 5 and 6.

This species is represented by many specimens of the internal molds, which are badly preserved. Some of them reveal nothing in the longitudinal sections, but others show important internal structures. Shell subcylindrical, straight, elliptical in transverse section, having two diameters at the ratio of nearly 7:6. Larger extremity not observed. The expansion of the ectoconch is very slow, being 1 in 15 mm.

The ectosepta are very crowded, and nearly equally separated from one another, attaining a distance of 1/9 the major diameter of the ectoconch at the lower preserved end and 1/10 at the upper. They are provided with tubi which continue beyond the preceding septum. Concavity of ectosepta not more than the depth of two cameræ.

The endoconch is subelliptical in section, lying at the extremity of the longer diameter and close to the outer conch. It measures 14 mm. in the major diameter and 11 mm. in the minor, where the corresponding measurements of the diameters of the ectoconch are 33 mm. and 27 mm. respectively. In general the inner shell is about 2/5 as large as the outer one.

Both endoconch and the cameræ are absolutely free from the organic or even the inorganic deposit. The ectosepta are well preserved in some specimens, but partly crushed in others. The ectotheca has not been preserved.

COMPARISON: Our species bears much resemblance to *Vaginoceras uniforme*, but the latter has not the following characters which are characteristic of the former: 1, ectosepta being more closely set, at a very short distance in their separation; 2, phragmacone enlarging much more slowly; 3, concavity of ectosepta being much deeper; 4, endoconch lying at the end of the major diameter instead of the minor; 5, organic deposit absolutely absent. It may be also distinguished from *Vaginoceras reedi* by the subelliptical, marginal and smaller endoconch. Even though the numerous ectosepta and some other aspects of this species are quite like those of *Vaginoceras vaginatum* Schlotheim[1], our shell has the smaller and subelliptical endoconch as well as the slower tapering, which are readily differentiated from those of Schlotheim's form.

HORIZON AND LOCALITY: From the upper Neichiashan formation near Sintan. western Hupeh. The specimens were collected by J.L. Smith and C.Y. Hsieh respectively.

1. Foord: Catalogue of Fossil Cephalpoda, Part I, p. 140.

Vaginoceras giganteum Yü (sp. nov.)

Plate III, Figs. 4 a-b.

Ectoconch straight, robust, cylindrical, enlarging very slowly. Endoconch rather large. As both the ectoconch and endoconch are much eroded, their cross sections are not quite certain, though they are probably circular. The apical portion is missing and the length of the incomplete body-chamber also can not be fully determined. This fragment has a length of 360 mm. comprising fourteen cameræ. At the two extremities it measures 67.5 and 48.5 mm. in diameter. It expands at the rate of 1 in 18.5.

Ectosepta thin, moderately concave, appearing much thickened on their upper marginal portion by the stereoplasmic deposit. They are distant from each other about one half the diameter of the ectoconch. Their concavity is about three fourths as deep as the camera. It is a noticeable fact that the ectoseptal distances are almost equal throughout the whole fragment. There are two cameræ within the space of 50 mm.

The endoconch lies ventro-centran. It is of large size, a little less than one third the diameter of the ectoconch. It is slightly contracted between the ectosepta. At the lower part of the fragment the endoconch is distant 11 mm. from the ventral side of the outer shell and 25 mm. from the dorsal, where the diameters of the ectoconch and endoconch are 52 mm. and 16 mm. respectively. It is only preserved in the lower portion and the upper end of the specimen, and the rest is completely worn away. The uppermost part of the endoconch encloses another smaller orthoceracone 10 mm. long. All the cameræ and the lower part of the endoconch are wholly filled with calcite deposit. No endosepta are seen, but the presence of the imbricating tubi and the enormous endoconch shows that this specimen should be referred to the genus *Vaginoceras*.

Comparison: This species may be related to *Vaginoceras wahlenbergi* Foord, but differs from that in the slower rate of tapering, equal ectoseptal intervals, and position of the endoconch. The same features also serve to differentiate this form from *Vaginoceras wahlenbergi* Foord var. *cylindrica*.

Horizon and Locality: Obtained from the fossiliferous bed underlying the red limestone near Ta-wu-shu, Chung-yang-hsien.

Vaginoceras? sp.

Plate VIII., Fig. 1.

This specimen consists wholly of the red lime matrix, in which the shell was embedded. It has a length of about 400 mm. On the surface of the stone nucleus the

sharp impressed annular lines are clearly shown, each one probably representing an ectoseptum. They are very crowded, and the distances between them vary to an extremely small degree, ranging from 11.5 to 12.5 mm. Generally sixteen cameræ are present in a length of 200 mm, while the ectoconch has a diameter of 66.5 mm. The ectoconch gradually diminishes its diameter toward the apical extremity at the rate of 1 in 11.5. On examining its sections no other features may be recognized except the scar of the endoconch, which is more or less elliptical in shape and situated close to the outer shell. Test not preserved at all.

Since we know nothing about the tubi, the actual size of the endoconch and other features, specific and generic determination is impossible. On account of the large, marginal endoconch and the uniformly separated ectosepta, which are somewhat related to *Vaginoceras uniforme*, it is provisionally put in the genus *Vagni ceras*.

Horizon and Locality: From the red bed north-east of Pei-hu-fu, Pu-chi-hsien.

Suborder **Orthochoanites** Hyatt

Family **ORTHOCERATIDAE** M'Coy

Genus **ORTHOCERAS** Breyn

Orthoceras chinense Foord

Plate III., Figs. 5a-b; Plate IV., Figs. 4a-b;

Plate V., Figs. 7a-c; Plate VI., Figs. 1a-b, 2a-c.

1856. *Orthoceras* sp., S. P. Woodward: Quart. Journ. Geol. Soc. Vol. XII, p. 378, pl. VI, fig. 1.
1888. *Orthoceras chinense*, Foord: Catalogue of Fossil Cephalopoda. British Museum. I. p. 100.
1911. *Orthoceras chinense*, Frech: Richthofen's China, Vol. V, p. 8, pl. II, figs. 2 a-c.
1920. *Orthoceras chinense*, Yabe et Hayasaka: Palæontology of Southern China, p. 48, pl. XXVII, figs. 3 a-b.

Shell (Pl IV., Fig. 4) straight, subcylindrical. Section circular. The preserved fragment tapers at the rate of 1:9. Both the initial portion and the larger end are wanting.

The septal interval gradually increases orad from the smaller extremity. After a certain distance it slightly reduces and immediately increases again. On the whole the cameræ become deeper as the shell expands in diameter, being approximately equal to one half the maximum width of the shell or even a little less. At a point not far from the living chamber the septa become more crowded toward the aperture. The septal necks are very long, extending apically for a distance equal to about one half the interspace between the septa. Septa thin, direct, having a concavity of 1/2 the depth of a camera or more.

Siphuncle central, narrow, measuring about 1/10 the diameter of the shell. It is circular in transverse section. It is entirely empty in some specimens, but partly filled with the secondary crystalline deposit in others. The margins of the septa are either perfectly free from any deposit or lined with a layer of stereoplasm, which is sometimes very thick and sometimes rather thin as well as irregular. The cameræ are filled with crystalline calcite of secondary origin, but generally empty.

A very small part of the test has been preserved, showing the transverse lines of growth.

There is another specimen (Plate V., Fig. 7), which was collected from the same locality and probably belongs to the same species. It is represented by a fragment of the apertural portion, having a length of 70 mm. The living chamber is partly preserved with three adjacent cameræ. The septal distance measures 15 mm. at the lowest camera of the fragment, and 10 mm. at the uppermost or last one, where the corresponding measurements of the diameter of the shell are 32 mm. and 36 mm. respectively. The surface is ornamentated by well marked transverse, flexuous, imbricating striæ, of which three are counted in a distance of 2 mm. The other internal characters of this individual are the same as those of the preceding one.

A third specimen (Pl. VI., Fig. 1.) is robust in form. It measure about 210 mm. in length. The living chamber is partly preserved and the apical portion is missing. The septal distances continually and gradually increase from the lower part of the shell toward the aperture, being little more than 1/2 the diameter. Up to the third camera from the living chamber, it stops to increase and gradually reduces upwards, where the depth of the cameræ is less than 1/2 the diameter. The septal necks are slightly shorter than 1/2 the septal intervals. Test not observed.

The body chamber in a fourth specemers (Pl. VI., Fig 2) is rather large. Because of the incomplete state of preservation its full length can not be made out, but the portion remaining reaches a length of 48 mm. or more than 1½ times the diameter of its base. The septal distances of the mature portion seem to be greater than those in the preceding specimens, measuring about 4/5 the shell diameter. The septa also become crowded as they approach the outer chamber. The test is not preserved, but the surface character may be seen on the mold of the interior, which is marked by regular, flexuous transverse lines of growth. The actual surface had its striæ arranged similarly, but they appear to have been much closer together. There is another small specimen (Pl. III, Fig.5.) which indicates the young stage of the same species.

Remarks. In the collection about ten specimens of this species are found, but there is a great variation in tapering between them. Some taper at the same rate as that of Foord's specimen, and others much more rapidly, varying from 1:6 to 1:8.

HORIZON AND LOCALITIES: This species is very common in the argillaceous limestone bed of the Neichiashan formation at Nei-chia-shan near Sin-tan of Tze-kuei-hsien (J. S. Lee), Lo-jo-ping of I-chang-hsien (C. Y. Hsieh) and Tai-hung-shan of Nan-chang-hsien (Coll. W. P. Shu and C. C. Yü).

Orthoceras chinense var. **kuangchiaense** Yü (var. nov.)

Plate VII., Figs. 1 a-c and 2.

Shell straight, slender, subcylindrical, regularly and gradually augmenting its diameter toward the chamber of habitation at the rate of 1:8.5. The preserved part of the living chamber measures 40 mm. long, the diameter at its base being 25 mm. Owing to the fact that the larger extremity is poorly preserved, the aperture is unknown. Shell section circular in outline.

Only two complete cameræ are preserved, increasing from 14 mm. in depth at the lower camera to 17 mm. at the upper or last one. At this stage the shell diameter ranges from 22 mm. to 24 mm. The septa are distant about 2/3 the diameter from each other. Concavity of the septa about 1/2 the depth of a camera or more.

Siphuncle central, circular in section, having a diameter of 2 mm., where the shell is 21 mm. in diameter. The septal necks are prolonged apicad only about 1/3 the interspace between the septa. The cameræ are lined with the stereoplasmic deposit about 1 mm. thick and filled with yellowish crystalline calcite inside.

The test is about one half millimeter thick. Its surface is covered by the broad, undulating lamellose growth lines without any longitudinal striæ. By the aid of a lens the transverse ridge are seen to be arranged in imbricating form, steepening at the anterior side and sloping very gently in the other direction. They are distant about 1 mm.

Another individual (Pl. VII, Fig. 2.) my probably be of the same form. It is represented by a perfectly preserved internal mold. It has a remarkable length of about 800 mm. with an acute apical termination. Transverse section unknown. It contracts toward the posterior end at the rate of 1 in 7.5. The body chamber is of considerable size, measuring 314 mm. in length and 93 mm. in width at its base. The depth of the cameræ increases from 18 mm. at the diameter of 30 mm., to 35 mm. when the diameter is 58 mm. The septa have a concavity equal to about 1/2 a camera height. The siphuncle is entirely eroded away, but near the smaller end there is some indication of the siphuncle showing its situation to be in the middle of the natural longitudinal section. This specimen appears to be compressed to a certain extent, presenting a

greater diameter of shell than the original maximum width. The camerae are filled with the fine yellow matrix of calcilutyte except the initial portion, which has turned into calcite.

COMPARISON: This form agrees in all respects with *Orthoceras chinense* Foord, but differs slightly in having shorter septal necks, longer septal distances and the gradual increase of camera depth towards the aperture, these features serving to separate it as a variety of Foord's species. It may be compared with *Orthoceras evanescens* Barrande[1], but is easily distinguished by its more rapid tapering, its surface ornamentation, its broader siphuncle and the regular increase of its septal distance. *Orthoceras penetrans* Barr.[2] and *Orthoceras cavum* Barr.[3] also come nearer to this form in general aspect, but our shell has longer septal necks and surface striation, which are very different from those of Barrande's species. It is also allied to *Orthoceras giebeli* Barr.[4], but that shell has different surface ornamentation and longer septal necks.

HORIZON AND LOCALITIES: The specimen (Pl. VII., fig. 1.) is from the same formation as the preceding species in the region about 1 li to the east of Chiang-chia-chi (蔣家集), and about 10 li north east of Kuang-chiao-pu, King-shan-hsien. (W. P. Shu and C. C. Yü). The last specimen (Pl. VII., Fig. 2) was obtained in the bed between the reddish limestone and the thick-bedded blue limestone at the place close to Wang-chia-sze, Chung-yang-hsien. (C. Li and W. P. Shu).

Orthoceras chinense var. eccentrica Yü (var. nov.)

Plate VIII., Fig. 2.

Shell cylindrico-conical, regularly enlarging. Transverse section circular. Chamber of habitation not perfectly preserved. This specimen is about 210 mm. in length, measuring 40 mm. in diameter at the larger extremity. The apex terminates in an acute point with an apical angle of 25°, but this is probably not the true angle as the apical portion is displaced by faulting and the section not wholly median. The normal rate of tapering of the shell may be estimated at 1 in 7. Surface markings unknown.

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1. Barrande: Système Silurien de la Bohême, Vol. II, Text III, p. 190, pl. 258, pl. 265; pl. 326, pl. 361.

2. J. Barrande: Système Silurian de la Bohême, Vol. II, Text III, p. 537, pl. 403, pl. 406.

3. J. Barrande: Système Silurian de la Bohême, Vol. II, Text III, p. 488, pl. 223, pl. 363, pl. 378, pl. 384.

4. J. Barrande: Système Silurian de la Bohême, Vol. II, Text III, p. 404, pl 304.

Septa gently concave, so far as observed, with a concavity equal to one half of the camera. The septal distance increases irregularly as the shell expands in diameter, having a depth varying from 12 mm. to 22 mm., where the corresponding diameters of the tube are 18 mm. and 35 mm. respectively.

The siphuncle is narrow, and equal to one tenth the diameter of the shell. It is eccentric, its border touching the central axis of the conch. It is enclosed by the septal necks, which, as determined from a few of them which are clearly shown in the longitudinal section, are comparatively short, about one third the depth of the camera. There is no trace of deposits in the siphuncle. All the cameræ contain the white crystalline lime in addition to the stereoplasmic lining.

COMPARISON: At first sight this specimen scarcely differs in aspect from *Orthoceras sp.*[1] figured by Woodward, but after close examination our shell may be distinguished from Woodward's shell by the excentric siphuncle, the shorter septal necks and the more remote septa. It closely resembles *Orthoceras chinense* Foord var. *kuang-chiaoense* except for the position of the siphuncle and some other minor features. Therefore, I am inclined to regard this form as another variety of Foord's species.

HORIZON AND LOCALITY: This shell was collected from the bed just underlying the reddish limestone at a place not far from Wang-chia-sze, Chung-yang-hsien.

Orthoceras chinense var. aquiseptatum Yü (var. nov.)

Plate VIII., Figs. 3-5; Plate IX., Figs. 1a-b.

Shell (Pl. VIII., Fig. 3) subcylindrical, robust, circular in cross section. Apical portion not observed. The diameters at the two extremities of this fragment are 34 mm. and 54 mm. respectively, the distance between them being 133 mm. The rate of increase is in the proportion of 1 to 6.5. Test not exposed.

The preserved part of the living chamber is about 70 mm. in length and 56 mm. in diameter at its base. Seven complete adjacent cameræ have been recognized, varying slightly in their depth. Thus each of the lowest two cameræ measures 20 mm. in length, while above these the septa are separated by a distance of 17 or 18 mm. Still higher up the cameræ assume again the same depth as the lowest one. In general they are of nearly the same depth, this being greater than 1/2 the diameter of the shell at the lower preserved end and less than 1/2 at the upper. The last camera is shallower than any of

1. S. P. Woodward: Quart. Journ. Geol. Soc., Vol. XII, p. 378, pl. VI, fig. 1.

the preceding ones, which is a common case occurring in the conchs of cephalopods. Septa moderately concave, having a depth nearly equivalent to one fourth the maximum width of the shell.

Siphuncle narrow, lying in the central part with a circular cross section. Its size is about 1/9 the diameter of the shell at the lower end, and 1/11 at the upper. The septal necks extend scarcely longer than 1/3 the septal interspace. The camerae are mainly filled with crystalline calcite, though some are also filled with the material in which the specimen is embedded.

One specimen of a different individual (Pl. VIII., Fig. 4.) represents a young shell of smaller size. The septate portion has a length of 68 mm. excluding the living chamber, which is very large or more than 3 times the diameter at its base or nearly about 1/2 the total length of the fragment. Rate of tapering 1 in 7.5. The septa are equally separated, being 7 mm. in distance, while the diameter of the conch measures 13 mm. at the lower end and 19 mm. at the upper. Siphuncle narrow, central, cylindrical, preserved only in the smaller extremity of the naturally sectioned specimen. It is about 1/9 the diameter in size.

The third specimen (Pl. IX., Fig. 1) collected from Tung-chiao-cheng, attains a length of 132 mm. and expands its shell at the rate of 1 in 7. It terminates in a blunt end at an apical angle of 15°. Shell slightly curved, which may be regarded as accidental. Cross section subcircular (probably by compression). Near the apical portion the septal distances gradually increase from 5 mm. to 10 mm., where the shell has the corresponding longer diameter of 9 and 19 mm. Above this stage the septa are 12 mm. distant from each other. Still higher up they have been crushed, but from what remains we know that they are also equidistant at an interval of about 12 mm. throughout the upper portion, where the shell enlarges its diameter from 22-27 mm.

Comparison: This form has some affinities with the *Orthoceras epulans* Barrande[1], but the septa in the latter form are much closer together and the septal necks much shorter. It is similar to *Orthoceras chinense* Foord except for the shorter septal necks and the equal septal distances, the last feature also serving to distinguish it from the other varieties of Foord's species mentioned above.

Horizon and Localities: The specimens (Pl. VIII., Figs. 3-4) were found in the beds overlying the thick blue limestone and underlying the red bed near Pei-hua-pu, Pu-chi-hsien (C. Li and W. P. Shu). The last one described (Pl. IX., Fig. 1) is abundant in the upper Neichiashan formation at Mei-hua-ling (梅花嶺) 12 li east of Tung-chiao-cheng, King-shan-hsien. There is still another specimen (Pl. VIII., Fig. 5.) of the same species was colleced from Heh-chia-tzui-tze (侯家咀子) 6 li north-west of Chang-chia-chi, Chung-hsiang-hsien, (Coll. W. P. Shu and C. C. Yü).

1. J. Barrande: Syst. Sil. de la Bohême, vol. II., Texte III, p. 432, pl. 373, pl. 399.

Orthoceras regulare Schlotheim.

Plate IV., Figs. 5, 6 a-b.

1888. *Orthoceras regulare*, Foord: Catalogue of Fossil Cephalopoda, Part I, p. 6. (With literature references).

1917. *Orthoceras regulare*, Reed: Palæontologia Indica, New Series, Vol. VI, Mem. No. 3, p. 32, pl. V, figs. 13, 13a.

There is a small shell which can be identified with this species. The larger portion has not been observed and the part remaining attains 45 mm. in length. It is straight and cylindrical in general form and subcircular (probably compressed) in cross section. Rate of increase about 1 in 15. Septa strongly concave and separated from each other a distance of about 1/2 the diameter of the shell. Depth of the septa exceeding 1/2 that of the camera. Siphuncle central, circular, being about 1/9 the shell diameter. It is distinctly girdled by the septal necks, which are extremely short. The white calcareous deposit is present in the cameræ, but not in the siphuncle. No test remains, but the surface of the mould seems to be transversely striated. In another specimen (Pl IV,, Fig. 6) the shell has a circular section, tapering at the rate of 1 in 18.

COMPARISON: In the septal distances and the position of the siphuncle, the present shell is somewhat close to *Orthoceras chinense* Foord, but our shell has the septal necks much shorter and the tapering much slower, features readily distinguished from those of *Orthoceras chinense*.

HORIZON AND LOCALITY: Embedded in the upper limestone bed of the Neichiashan formation, near Sin-tan (C. Y. Hsieh Collector).

Orthoceras cf. politum M'Coy

Plate III., Fig. 6

1888. *Orthoceras politum*, Foord: Catalogue of Fossil Cephalopoda, Pt. I, p. 7. (With literature references).

Shell straight, slender, embedded in the yellowish argillaceous limestone. Only the apical portion is recognized, with six cameræ remaining. The cross section is circular. Because the longitudinal section is oblique to the axis of the shell, the siphuncle is only partly exposed at the upper end. It tapers at the rate of 1 in 10. The distance between the septa slightly and gradually increases upwards, ranging from 2/5 the diameter at the lower end to 1/2 at the upper end of the fragment. Depth of septa about 1/4 the shell diameter. Siphuncle circular, central, having a diameter about 1/7—1/6 the diameter of the shell. Septal necks extending less than 1/4 the depth of the camera. The surface markings of the test are unknown.

COMPARISON: This fragment may be correlated with *Orthoceras chinense* Foord[1] and *Orthoceras regulare* Schlotheim[2], but differs from the former in having much shorter septal necks and from the latter in the more rapid tapering. So far as the visible characters of this fragment are concerned, it may be assigned to the present species. According to the description[3] given by Foord the siphuncle of M'Coy species is "central in the young shell, but becoming eccentric with growth" and the surface is covered "with fine transverse striæ of growth". But the specimen in our possession only represents the young stage, and the position of the siphuncle in the upper part as well as the surface character are quite obscure. The specific identification of this specimen, therefore, is made with a certain amount of hesitation.

HORIZON AND LOCALITY: From the limestone bed of the Neichiashan formation at Ta-hung-shan, Nan-chang-hsien.

Orthoceras squamatulum Barrande.

Plate IV., Figs. 7a-b.

1868. *Orthoceras squamatulum*, Barrande: Système Silurien de la Bohême, Vol. II, Texte III, 1874 p. 455, pl. 302, pl. 310, pl. 370.

Shell straight, cylindrical, represented by a fragment of the posterior end, which is 40 mm. long. Transverse section circular. It expands in diameter very gently, the rate being about 1 in 30. The diameters at the two extremities of the fragment are 13 and 14 mm., while that of the siphuncle is 1.5 mm. wide throughout the whole portion of the specimen.

The septa are very shallow, about 1/3 the depth of the cameræ. This fragmentary specimen contains four cameræ, which have a depth of 2/3 the diameter of the shell. In actual measurement the septa are 9 mm. apart at a diameter of 13 mm.

Siphuncle slightly excentric, narrow, being about 1/7 the diameter of the conch. Cross-section circular. Septal necks clearly shown and extremely short. The cameræ consist of the same material as the surrounding rock. Test not preserved, but the surface of the mould indicates that slightly oblique striæ are present, four occupying a distance of 1 mm.

COMPARISON: *Orthoceras michelini* Barr.[4] somewhat corresponds to the present specimen, but Barrande's species has the septal distance much longer. Our shell is

1. Foord: Catalogue of Fossil Cephalopoda, Pt. I, p. 100.
2. Foord: Catalogue of Fossil Cephalopoda, Pt. I, p. 5.
3. Foord: Catalogue of Fossil Cephalopoda, Pt. I, p. 7.
4. Barrande: Syst. Sil. de la Bohême, Vol. II, Texte III, 1874, p. 642, pl. 221, pl. 381, pl. 442, pl. 447.

also similar to *Orthoceras regulare* Schlotheim[1] and *Orthoceras politum* M'Coy[2], but differs from them in having a much slower rate of tapering and much longer septal intervals, It may be also distinguished from *Orthoceras scabridum* Angelin[3] and *Orthoceras sodale* Barrande[4] by the more gentle tapering and the siphuncle being not central in position.

HORIZON AND LOCALITY: Found in the upper Neichiashan formation near Sin-tan.

Orthoceras thyrsus? Barrande

Plate VII., Figs. 3a-b.

1870. *Orthoceras thyrsus* Barrande: Syst. Sil. de la Bohême, Vol. II, Texte III, 1874, p. 555, pl. 405, figs. 15-18.

A fragment has been obtained with only three air chambers preserved. The transverse section of the shell is circular. The rate of expansion is very gentle, measuring about 1 in 20.

The septa are provided with septal necks, which extend backwards to a very short distance. The depth of the septa is apparently about 1/2 that of the cameræ. The distance between the septa is approximately equivalent to 4/5 the diameter of the conch.

The siphuncle occupies the position between the periphery and the center of the shell, being nearer to the latter than to the former. It is circular in section, having a size of about 1/10 the diameter.

The test is partly preserved. Its surface seems to be covered by an ornamentation of oblique striæ, which, however, are not very clearly shown.

COMPARISON: This specimen may be related to *Orthoceras pleurotomum* Barrande[5], but differs from it in the possession of a circular shell, in a different character of surface markings, and in some other points. The only species which can be identified with the present specimen is *Orthoceras thyrsus* Barrande. But Barrande's species was collected from the Silurian rocks, while our shell makes its appearance in the upper Neichiashan formation of Middle Ordovician age. Therefore, if this species did not originate in pre-Silurian time, then this correlation may be wrong.

HORIZON AND LOCALITY: Upper division of Neichiashan formation near Sin-tan.

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1. Foord: Catalogue of Fossil Cephalopoda, Pt. I, p. 5.
2. Foord: Catalogue of Fossil Cephalopoda, Pt. I, p. 7.
3. Angelin-Lindström: Fragmenta Silurica, p. 4, t. IV, figs. 6-9; t. VII, figs. 8-10.
4. Barrande: Syst. Sil. de la Bohême, Vol. II, Texte III, 1874, p. 453, pl. 417, figs. 9-21.
5. Barrande: Syst. Sil, de la Bohême, Vol. II, Texte III, 1874, p. 412, pl. 224, pl. 296, pl. 366.

Orthoceras remotum Yü (sp. nov.)
Plate VII., Figs. 4 a-b.

Shell slender, elongate, cylindrical. Transverse section elliptical. It tapers very slowly, about 1 in 19. The fragmentary specimen has a length of 225 mm. embracing 10 cameræ. The two extremities have not been observed.

Septa strongly concave and very distant from each other. Their concavity is nearly equivalent to two fifths of the interspace between the septa. The cameræ regularly increase in depth as the shell expands in diameter, measuring 18 mm. in the smaller portion and 26 mm. in the upper, while the shell is 21 mm. and 29 mm. in dorso-ventral diameter respectively. The obliquity of the septal lines makes an angle of 70° with the median axis of the siphuncle and meets the side of the shell at 40°.

The siphuncle is strongly excentric, being 9 mm. distant from the nearer side of shell at the upper end and 6 mm. at the lower. It is narrow and elliptical in cross section. Its major and minor diameters are 3.5 and 2.5 mm., while the corresponding diameter of the shell are 30 mm. and 23 mm. respectively. The septal necks are not clearly exposed, but at the smaller end they may be perceived to have a very slight length.

Test smooth, being 0.5 mm. in thickness.

Comparison: This species is characterized by the strong concavity of its septa and the great depth of its cameræ. It may be compared with *Orthoceras pleurotomum* Barrande[1] and *Orthoceras thyrsus* Barrande,[2] but is readily distinguished from the latter by the great septal distance, the elliptical section of shell and the absence of the surface ornamentation; and from the former by the fact that the shell is covered by delicate oblique striations, while the septal intervals become crowded upwards.

Horizon and Locality: It occurs in a polished slab collected from the upper bed of the Neichiashan formation at Chai-tze-shan (柴子山) about 10 li south of Fang-chia-chi (方家集), Hsiang-yang-hsien (襄陽縣).

Orthoceras rudum Yü (sp. nov.)
Plate IV., Figs. 8a-c.

Shell straight, cylindrical, enlarging very slowly. Transverse section slightly elliptical. In this imperfect specimen only the basal portion of the body-chamber is preserved together with three adjacent ordinary cameræ. The entire length of the fragment is 70 mm. The rate of increase may be computed as 1 in 20.

1. Barrande: Syst. Sil. de la Bohême, Vol. II, Texte III 1874, p. 412, pl. 224, pl. 296, pl. 366.

2. Barrande: Syst. Sil. de la Bohême, Vol. II, Texte III, 1874, p. 555, pl. 405, figs. 15-18.

Septa strongly concave. They are widely separated, and slightly increase in distance apart toward the outer chamber. The concavity is about equal to one third of a camera which has a depth of 16 mm. in the last camera and 15 mm. in the next preceding one, while the dorso-ventral diameters of the tube at the corresponding stages are 20 mm. and 18 mm. respectively.

Siphuncle excentric, nearer to the center than to the side. It is encircled by the septal necks, which contract at the septa and gradually enlarge backwards, extending to a distance of about one third the septal interval. Transverse section ovately elliptical. It has a longer diameter of 3 mm. and a shorter of 2 mm. At the same place the shell measures 17. 5 mm. and 17 mm. in the dorso-ventral and transverse diameters.

The test is well preserved, having a thickness of 0.5 mm. The surface is marked by coarse, transverse, elevated, flexuous lines of growth, 6 in the space of 5 mm. On close examination under the magnifier we find that either the elevated ridges or the depressed interspaces are wholly composed of the fine striæ, slightly arching forward on the dorsal side.

Comparison: It is similar to the preceding species in all respects except in its striking surface ornamentation. This species may be compared with *Orthoceras pleurotomum* Barrande,[1] but differs from that by its gradual increase of septal distance and by the character of the transverse undulating striæ. It may be distinguished from *Orthoceras thyrsus* Barrande[2] by the fact that the latter has a circular section of the shell, and the oblique, straight striae on its surface.

Horizon and Locality: From the bed immediately underlying the red limestone at the region not very far from He-chiao, Chung-yang-hsien (C. Li and W. P. Shu Coll.)

Orthoceras suni Yü (sp. nov.)

Plate V., Figs. 8a-b, 9.

Shell straight, cylindrico-conical. Transverse section subelliptical. The only preserved part is the apical portion of 82 mm. in length, gradually expanding toward the apertural end. Mature phragmacone and body chamber not preserved. Apical angle 20°. Rate of incrase about one millimeter in a length of four millimeters.

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1. Barrande: Syst. Sil. de la Bohême, Vol. II, Texte III, 1874, p.412, pl. 224, pl. 296, pl. 366.
2. Barrande: Syst. Sil. de la Bohême, Vol. II, Texte III, 1874, p.555, pl. 405, figs. 15-18.

Septa thin, having a concavity exceeding one half the depth of a camera. The septa are 5 mm. distant from each other at the point where the longer diameter of the shell is 14 mm., and gradually increase their interspaces to 9 mm where the diameter of the shell is 23 mm.

Siphuncle central, being ovately elliptical in section. Its major diameter measures 2 mm. at the smaller and 3 mm. at the larger end of the preserved fragment. At the corresponding place the conch varies in its diameter from 16 to 26 mm. The sides of the siphuncle are distinctly marked by the septal necks, which are a little longer than one third the septal distance.

Near the smaller extremity the cameræ seem to have been separated horizontally into two nearly equal parts by a process directed toward the anterior angle on each side of the camera. This feature is apparently similar to that seen in the specimen of *Orthoceras sp.* Woodward.

Another fragment of smaller size was also obtained. It has a length of 40 mm. containing 11 cameræ with an apical angle of 20°. The apex is more pointed and the rate of tapering is more rapid, being 1:3.

Comparion: This species closely resembles *Orthoceras thomsoni* Barrande [1], but differs from it in the shorter septal distances, narrower siphuncle, and sub-elliptical sections of both the siphuncle and the shell. This form also bears some degree of resemblance to *Orthoceras* sp.[2] figured by Woodward, but the former has a more rapid rate of tapering and a subelliptical section of shell.

Horizon and Locality: In beds just overlying the blue thick-bedded limestone at the western end of Pei-yang-shan, Chung-yang-hsien. The specific name is given in honor of Dr. Y. C. Sun of the Geological Survey.

Orthoceras elongatum **Yü** (sp. nov.)

Plate VII., Fig. 5.

This species is well shown in a natural polished longitudinal section. Shell elongate, slender, and conical, having a length of 275 mm. The initial portion is pointed with an apical angle of 8°. It expands slowly toward the larger end. At a stage 262 mm. distant from the apex, it has a diameter of 22.5 mm. Rate of increase 1 in 14. Cross section of shell circular. Body chamber and surface character unknown.

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1. Barrande: Syst. Sil. de la Bohême, Vol, II, Texte III, 1874, p. 684, pl. 214, figs. 4,5.
2. Woodward: Quart. Journ. Geol. Soc., Vol. XII, p.378, pl. VI, fig. 1.

Septa gently concave, increasing in their distance from 3/4 to 4/5 the diameter of the shell. At the stage where the shell is 11 mm. in diameter, the camera is 9 mm. in depth, while at the uppermost preserved end the septa are 19 mm. distant from each other, being little less than the shell diameter which is 21 mm. at this place. Concavity of septa approximately equal to one third the depth of a camera.

The siphuncle is very slightly eccentric, cylindrical, and very narrow. Its diameter is about 1/14 that of the shell. The septal necks do not show very clearly, but seem to be very short. The organic deposit is well developed along the margins of the septa.

COMPARISON: This form is characterized by its great septal distances. It comes very near in aspect to *Orthoceras currens* Barrande,[1] but is differentiated from it by the much narrower siphuncle, slower rate of tapering and much shorter septal necks. The same characters in addition to the longer septal distance also distinguish this species from *Orthoceras chinense* Foord.

HORIZON AND LOCALITY: This specimen was procured from the bed underlying the reddish limestone near Ta-wu-shu, Chung-yang-hsien.

Orthoceras densum Yü (sp. nov.)

Plate VI., Figs. 3a-b; Plate IX., Fig. 2.

Shell cylindrico-conical with transverse section subcircular. Tube regularly enlarging in diameter upwards. Apical angle about 8°. The larger extremity as well as the surface character not observed. Tapering at the rate of 1 in 9.

The cameræ are extremely closely arranged in the apical portion, fourteen being counted in a distance of 20 mm. commencing from the apex. They are six in number in the next succeeding space of 20 mm. higher up. During the mature stage the cameræ greatly increase their depth, ranging from 10 to 17 mm., while the corresponding diameter of the shell is from 14.5 to 20 mm. Near the upper end where the shell has a diameter of from 20 to 30 mm., the septal distance scarcely increases, remaining about 16-17 mm. high.

Septa smooth, thin, having a convexity nearly equal to one half the depth of one camera, or a little more. Siphuncle narrow, central, circular in section, and apparently enclosed by the septal necks which extend not less than one third the septal distance. Its diameter is about 1/7 that of the shell.

1. Barrande: Syst. Sil. de la Bohême, Vol. II, Texte III, 1874. p. 628, pl. 221, pl. 222, pl. 407, pl. 411.

Another small specimen (Pl. IX., Fig. 2) of the same species was found. Its body chamber has only a small part of the base preserved. It gradually decreases in diameter apicad, to an acute point with an apical angle of 10°. Rate of increase 1 in 7.5. The septa at the smaller end are very numerous, being more than 10 cameræ within the length of 20 mm. After the rapid increase of the septal distances in the middle part of the conch, the cameræ apper to be retarded in the rate of increase in depth as compared with its diameter. Near the larger extremity where the diameter is 13 mm. the septa are distant about 7 mm.

Remarks: This species is distinct from any of the preceding ones in its extremely crowded cameræ at the apical portion and the irregular increase of the septal distance. I have not found any related form, with which this species may be identified.

Horizon and Localities: One speciemen (Pl. VI., Fig. 3) was obtained from the upper part of the Neichiashan formation at Chien-tze-kou about 3 li to the west of Nan-chang-hsien, and the other (Pl. IX., Fig. 2), from the same bed at Liu-chia-chung (劉家冲) about 15 li west of Kueng-chia-wang, I-cheng.

Orthoceras yangtzeense Yü (sp. nov.)

Plate III., Figs. 7, 8a-b.

There are three specimens of internal moulds which are cylindrico-conical and slightly curved. The cross section is elliptical, its two diameters being at the ratio of 3:2. Its tapering is rather rapid, about 1 in 6. Larger extremity not preserved.

It is to be noted that the septal sutures are slightly undulating and form on the convex side the V-shaped lobes, which are very characteristic of this species. The septal distances are very uniform and are about three millimeters apart on the average, while the longer diameter of the shell is 8 mm. at the lower end and 14 mm. at the upper end of this fragment, which is little less than 40 mm. in length.

The position of the siphuncle is rather uncertain. But the upper end of one specimen (Pl. III., Fig. 8) shows that it is small, circular, submarginal to the shell wall opposite the side which bears the V-shaped lobes.

Comparison: In the closer septa and the V-shaped lobes the present species somewhat resembles *Orthoceras* sp.[1] figured in Angelin-Lindström's *Fragmenta Silurica*. Since no description of that form was given, we are not able to make any accurate comparisons.

1. Angelin-Lindström: Fragmenta Silurica, t. IV, fig. 16.

HORIZON AND LOCALITY: The upper Neichiashan formation yields this form near Sintan, Tze-kuei-hsien (Collections: J. L. Smith and C. Y. Hsien respectively)

Orthoceras? wongi Yü (sp. nov.)

Plate V., Figs. 10a, b.

The weathered surface of this specimen appears to be annulated outside. But after a careful study we find that all the transverse depressions are just in the positions of septal sutures. In another smaller shell probably belonging to the same species, the surface is rather smooth, though it also slightly exhibits a longitudinal undulation to some extent. It may be concluded that the annulation-like sculpture is probably the result of the weathering. Shell straight, cylindrical, having a length of about 40 mm. It has a sub-elliptical section. The expansion of the conch is slow, about 1 in 10 or more. Both the extremities are missing.

The septal sutures are slightly undulating. The septal distances are approximate and uniform, being about 1/8 the shell diameter, which is also the concavity of the septa. In actual measurement the septa are 3 mm. apart throughout the whole fragment, which has a longer diameter of 20 mm. at the lower end and 24 mm. at the upper.

The siphuncle is subcentral, cylindrical, being 3.5 mm. in diameter. It is circular in section. It is a remarkable thing that the septal necks assume the character of those in Holochoanites, extending beyond the preceding septa for a little distance. The interior of the siphuncle is empty. A few cameræ are partly filled with the crystalline calcite.

REMARKS: The siphuncle of this form is not very large, suggesting the ordinary size of an *Orthoceras*, though having such long septal necks. I hesitate to consider this as another distinct genus. The generic name, now applied to our shell is only provisional.

HORIZON AND LOCALITY: Same as the preceeding species, with which the present form is associated.

Orthoceras sp.

Plate IX., Fig. 3.

Shell small, slender, slightly curved, enlarging very slowly. The transverse section is nearly circular. The initial portion as well as the body-chamber unknown. Rate of increase 1·27.

The thin septa are rather oblique, sloping back more than 20° and dying away on the convex side. No trace of the siphuncle can be recognized though it seems to be marginal to the convex side. The distances between the septa vary from 8 to 10 mm., where the shell increases in diameter from 15 mm. at the lower to 18 mm. near the upper end. The cameræ are entirely occupied by the dark gray lime-mud. The total length of the imperfectly preserved specimen is 108 mm.

The test is preserved in some places. It is rather thin, showing a thickness of 0.1 mm. Its surface is apparently smooth.

COMPARISON: This specimen is remarkable because of the obliquity of its septa, a feature not seen in any of the preceding specimens described. It comes very close in general aspect to *Orthoceras durinum* Blake,[1] from the Lower Llandeilo Limestone of Durness, but in the latter form the rate of tapering is less rapid and the septal distances are shorter than they are in the present form. It may also be separated from *Orthoceras baculoides* Blake[2] by its much slower tapering and by the apparently eccentric position of its siphuncle, which is central and large in Blake's species.

HORIZON AND LOCALITY: At Pei-ting-tze (碑亭子) 15 li west of Hu-chia-chi, Chung-hsiang-hsien, where the upper part of the Neichiashan formation is very prominently developed.

Orthoceras sp.

Plate IX., Fig. 4.

Shell straight, cylindrico-conical and of moderate size. It rapidly tapers backwards to an acute point with an apical angle of 15°. The shell section is elliptical? Test not observed. The siphuncle has been completely rubbed away.

The septa are thin, direct and numerous. They are 3 mm. distant from each other near the initial part. At the last camera 140 mm. from the apex, the septal interval increases to 9 mm. while the diameter of the shell is 21 mm. The rates of increase are different at the different stages of the conch. Thus, it is rapid at the apical portion, being about 1 in 4. Above this place 40 mm. from the apex, the shell tapers less rapidly at the rate of about 1 in 8.5. Near the larger end the tapering is reduced to 1 in 11. Since the polished section is not a median one, neither the diameter nor the tapering of the specimen can be taken as accurate.

REMARKS: This specimen is characterized by its numerous septa and its variable rate of increase in the different stages of the same individual. Since it is only in part preserved, its characters are insufficiently shown for specific determination.

1. Blake: British Fossil Cephalopoda, Pt. I, p. 83, pl. III, figs. 3, 3a.
2. Blake: British Fossil Cephalopoda, Pt. I, p. 82, pl. III, fig. 2.

Horizon and Locality: From a polished slab on the pavement along the road from Cha-ti-pu to Chang-chia-chiao, Hsien-ning-hsien, where the country rock is grey thin-bedded limestone corresponding to the reddish limestone in Chung-yang.

Family **CYCLOCERATIDAE** Hyatt

Genus **PROTOCYCLOCERAS** Hyatt

Protocycloceras deprati Reed

Plate VI., Figs. 4a-b, and 5.

1917. *Orthoceras* (*Protocycloceras*?) *deprati*, Reed: Palæontologia Indica, New Ser. Vol. VI, Mem. No. 3, p. 33, pl. V, fig. 15.

1928. *Protocycloceras* (?) *deprati*, Kobayashi: Japanese Journal of Geology and Geography, Vol. V, No. 4, p. 184, pl. XIX, fig. 5.

Fig. 4

Fig. 5

Fig. 6

Fig. 7

Fig. 4. *Protocycloceras deprati*. Front view of an internal mould, showing the annualations. Natural size.

Fig. 5. *Protocycloceras deprati*. Side view of the same. Natural size.

Fig. 6. *Protocycloceras deprati*. End view of the same, showing the eccentric siphuncle. Natural size.

Fig. 7. *Protocycloceras deprati*. Portion of the test of another smaller individual. Enlarged five times.

This species is represented by numerous specimens, which are all internal moulds but belong to the same species. In taking the longitudinal section the interior of the specimen is wholly empty without any trace of the internal structures. Nevertheless, the characteristic surface annulations and the position of the siphuncle are cleary shown on the exterior of the moulds.

Shell straight, annulated, with a slightly elliptical section. Owing to the moulds not being well preserved the rate of tapering can not be precisely determined, but in general the conch enlarges in diameter very slowly, about 1 in 20 or even less. Its surface is encircled by coarse, concentric annulations, which are oblique to the axis of the shell and nearly uniformly separated from each other. In some smaller specimens they are distant about 5 mm., but in the larger ones the distance is 6 or 7 mm. from the summit of one ridge to that of the other. The oblique annulations are arched on the opposite side to form broad saddles, which ascend about equal to the space separating them. They occur as ridges with round edges. The interspaces between them are concave and round. In one specimen (Pl. VI., Fig. 5) the annulations and the interspaces between them are again covered with very regular, fine striæ, of which more than ten are contained in a length of 1 mm. No longitudinal striæ are seen at all.

The siphuncle is subcentral and slightly subcircular. It is nearer to the center than to the side of the shell. Its diameter is 4 mm., where the shell measures 21 mm. in minor diameter and 24 mm. in major. It occupies the position across the dorso-ventral diameter and opposite the side bearing the broad saddles.

Remarks: According to Reed's description[1] the rate of tapering is "at about 1 in 40" and the annulations are "arched up strongly to form a broad high ventral saddle on the siphonal side." I think that Reed only obtained one piece of the broken shell, so the measurement of the tapering may be misleading. Regarding the siphuncle he stated: "The position of the siphuncle is rather obscure", while our specimens indicate the siphuncle lying at one side of the center just opposite the saddles. In any case our shell is undoubtedly the same as Reed's species.

Horizon and Locality: This species prevails in the upper part of the Neichiashan near Sin-tan, western Hupeh. Many specimens were collected by J. L. Smith and C. Y. Hsieh respectively.

Genus **Cyclocerас** M'Coy

Cyclocoras sp.

Plate VI., Fig. 6

Shell straight, cylindrical, and annulated. Section unkown. Only a part of the conch is preserved, being 23 mm. in length. Even though no test remains, yet the surface markings may be examined on the surface of the internal mould. Siphuncle and septa also unknown.

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1. loc. cit.

The mold is covered by six transverse prominent annulations, which are separated by concave interspaces about 3.5 mm. wide. The annulations are slightly oblique and moderately sharp. Near the uppermost end of the fragment the depressed space is ornamented by numerous fine subimbricating striae, running parallel to the projecting annulations. Besides these, there are a few indistinct longitudinal ridges across the fine transverse striæ.

REMARKS: This specimen is very poorly preserved and the data available are not sufficient for specific identification, even though in external character it is somewhat allied to *Cycloceras peitoutzense* Grabau[1] to a certain degree.

HORIZON AND LOCALITY: From the Yellowish-green shale of the lower Neichiashan formation at Tai-hung-shan, Nan-chang-hsien.

Family **TROCHOLITIDAE** Hyatt

Genus **DISCOCERAS** Barrande

Discoceras eurasiaticum Frech.

Plate IX fig. 5, 6 a-b.

1911. *Discoceras eurasiaticum* Frech: Richthofen's China, Vol. V, p. 5, pl. I, figs. 1a-2b.

1920. *Discoceras eurasiaticum*, Yabe and Hayasaka; Palæontology of Southern China, p. 54, pl. XVIII, figs. 2a-b.

Shell (Pl. IX., Fig. 6) discoidal, consisting of about four volutions, which expand in height very slowly. The diameter of the shell measures 45 mm. from the apertural portion to the opposite periphery passing through the middle part of the umbilicus. The dorsal side of the volutions is slightly impressed by the preceding one. The cross section of the whorl is subquadrate in outline. Near the apertural end it is 15 mm. in breadth and 10 mm. in height. The siphuncle is very small and marginal to the internal side. The surface of the shell is covered by oblique transverse sharp costæ, which bend backward from the internal side toward the external.

There is another well-preserved specimen (Pl. IX., Fig. 5) which is somewhat larger. A part of the test is broken, and the septa are distinctly exposed. The septal distance is greater at the ventral side than at the dorsal. The cameræ are very shallow and increase in depth very slightly. In the gerontic stage the septa are 3.5 mm. distant at the center, while the whorl is about 14 mm. high. The costæ are very numerous, three occurring in a space corresponding to the depth of one camera.

HORIZON AND LOCALITY: The specimens were found in the upper part of the Neichiashan formation at Nei-chia-shan near Sin-tan of Tze-kuei-hsieh, western Hupeh. (J. S. Lee Coll.)

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1. Grabau: Palæontologia Sinica, Ser. B, Vol. I, fasc. 1, p. 63, pl. VI, Figs. 1-4.

Family **LITUITIDAE** Noetling
Genus **LITUITES** Brogniart
Lituites lii Yü (sp. nov.)
Plate IX., Fig. 7.

The shell is a gyroceracone in the young and becomes straight in the adult stage. Section subcircular. This form is represented by only one specimen which occurs in a natural longitudinal section and can not be separated from the enclosing rock. Therefore, nothing is known of the surface ornamentation of the shell. Apertural portion not preserved.

The coiled part of the conch includes about two volutions. The whorls are separable about 1 mm. or a little more near the apical part, and 2.5 mm. at the place where the second or last volution ends and the shell begins to straighten. The diameter of the coiled part measures about 35 mm. from the larger end of the last whorl to the opposite side across the volutions. In the central part of the first volution there is an open space with a diameter of about 7 mm. The straight part of the shell is slightly bent inwards and attains about 70 mm. in length, expanding slowly at the rate of 1 in 22.

Septa simple, thin, moderately concave. They are more curving forward on the internal or the dorsal side. The intervals between the septa gradually increase toward the aperture. They are about 1/2 the diameter of the shell. At the second volution there are eleven septa in the distance of half a whorl or a length of about 44 mm. Near the larger preserved end they are 9 mm. apart, where the shell has a diameter of 15 mm.

Siphuncle narrow, tubular, lying dorsal of the center. At the upper portion it is 2 mm. distant from the internal side and 11 mm. from the external. In the same stage the widths of the siphuncle and the conch are about 2 mm. and 15 mm. respectively. It is apparently empty, and the septa appear thickened on both upper and lower marginal portion with white organic deposit.

REMARKS: Owing to the fact that the specimen is not well preserved, the generic determination of this form is somewhat doubtful. Foerste said.[1] "It is well known at present, however, that the chief characteristic of true *Lituites* consists of the presence of deep ventral and dorsal sinuses, shallow lateral sinuses and intermediate crests." In our shell the apertural end has not been preserved, whether it is provided with such sinuses and crests or not is not known. Furthermore, the coiled part of this form is also different from that of the genotype *Lituites lituus* Montfort, which has the volutions entirely in contact. Foerste proposed in 1925 the new generic name

1. Foerste: Notes on Cephalopod Genera; chiefly coiled Silurian forms, p. 18.

Bickmorites, taking *Lituites bickmoreanus* Whitfield as its genotype. According to the description[1] given by Foerste *Bickmorites* is a gyroceracone in the early stages with strongly marked transverse rib-like annulations and some other important surface ornamentations, and its siphuncle lies slightly ventral of the center. Although our specimen closely resembles *Bickmorites* in some aspects, its siphuncle is located near the dorsal side and its inner side shows a fairly straight profile in the longitudinal section, indicating that there are no annulations at all. It is not desirable to make a new genus for our shell until we obtain other specimens of the same form which show the external characters.

From the specific point of view, the present form may be related to *Lituites latus* Angelin[2], but the more slender, more slowly tapering, and less bent, straight portion sufficiently distinguishes our shell from Angelin's species.

Horizon and Locality: This specimen came from the bed just below the reddish limestone at He-chiao, Chung-yang-hsien. The specific name is given in honor of Mr. C. Li, geologist to the Institute of Geology, National Research Institute of China (C. Li and W. P. Shu Coll.)

Suborder **Cyrtochoanites** Hyatt

Family **ONCOCERATIDAE** Hyatt

Genus **ONCOCERAS** Hall

Subgenus **MELOCERAS** Hyatt

Meloceras asiaticum Yabe

Plate IX., Figs. 8, 9a-c.

1911. *Cyrtoceras* (*Meloceras*) cf. *ellipticum*, Frech: Richthofen's China, Vol. V, p. 6, pl. II, figs. 3a-c.

1920. *Cyrtoceras* (*Meloceras*) *asiaticum*, Yabe: Palæontology of Southern China, p. 52, pl. XVIII, fig. 14; pl. XXVII, figs. 7a-b.

This species is represented by several fragments, which enlarge in diameter very gently. In one of the smaller specimens (Pl. IX., Fig. 9) it is uniformly arcuate and about 40 mm. long along its convex side. The cross section is ovately elliptical. The internal side seems to be thicker than the external. The siphuncle is situated nearly marginal to the external side. It is circular in section and very small in size, measuring 1 mm in diameter, where the corresponding measurements of the shell are 15 mm. in the dorso-ventral diameter and 12.5 mm. in the transverse.

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1. Foerste: loc. cit. p. 47.
2. Angelin-Lindström: Fragmenta Silurica, p. 9, Tab. XI, figs. 1-4.

The septa are very closely arranged. The septal distance is about 1.3 mm. at the initial portion and very slightly increases to 1.8 mm. at the upper part of the fragment. The septa are more separated along the convex side than on the concave. The cameræ have been filled with white calcite, but the siphuncle is completely empty, except for the mud filling.

The test is rather thick, being about 0.5 mm. Its surface is covered with transverse striæ, which are very fine.

Horizon and Locality: Same as *Discoceras eurasiaticum* Frech, with which the present specimens are associated. (J. S. Lee Collector).

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EXPLANATION OF

PLATE I

PLATE I.

Fig. 1. *Cameroceras* cf. *styliforme* Grabau. Nat. size..... p. 23
View of a portion of the endoconch embedded in rock.
Loc:—Lo-jo-ping, I-chang-hsien, W. Hupeh. (G. S. C. Cat, No. 2826)

Fig. 2. *Cameroceras* cf. *styliforme* Grabau. Nat. size..... p. 23
2a. External view of endoconch, showing the oblique ectoseptal edges on the external surface of the endotheca.
2b. Cross section of the same specimen, showing older endosepta, the aperture of the endocone and the form of the endoconch.
Loc:—Lo-jo-ping, I-chang-hsien, W. Hupeh. (G. S. C. Cat. No. 2827)

Fig. 3. *Cameroceras* cf. *styliforme* Grabau. Nat. size..... p. 23
Longitudinal section of an endoconch, showing the endosepta.
Loc:—Lo-jo-ping, I-chang-hsien, W. Hupeh. (G. S. C. Cat. No. 2828)

Fig. 4. *Cameroceras hsiehi* Yü. Nat. size..... p. 25
4a. Longitudinal section, showing the endotheca, last endoseptum, endocone and ectosepta.
4b. Cross section of same, showing the circular endoconch which is in juxtaposition with the ectoconch.
Loc:—Near Sin-tan, Tze-kuei-hsien, W. Hupeh. (G.S.C. Cat. No. 2831)

Fig. 5. *Cameroceras subtile* Yü. Nat. size..... p. 26
5a. Longitudinal section of a mature portion, showing the endotheca and the nature of stereoplasmic deposit in the cameræ.
5b. Cross section, showing the excentric endoconch.
Loc:—near Sin-tan, Tze-kuei-hsien, W. Hupeh. (G.S.C. Cat. No. 2832)

Fig. 6. *Endoceras leei* Yü. Nat. size..... p. 28
A natural weathered section, showing the tubi, one camera in length, and the acute apical angle formed by the endosepta.
Loc:—San-shan-yuan, Chung-yang-hsien, SE. Hupeh. (N. R. I. Cat. No. 1)

Fig. 7. *Endoceras leei* Yü. Nat. size..... p. 28
7a. Natural polished section, showing the length of tubi and the last endoseptum. The endoconch is wholly filled with calcite deposit.

C. C. Yü: Ordovician Cephalopoda of Central China Pl. I.

7b. Cross section at the apical end of endoconch of the same specimen, showing the excentric endosiphuncle and the form of endoconch.

Loc.:—He-chiao, Chung-yang-hsien, SE. Hupeh. (N.R.I. Cat. No. 2)

Fig. 8. *Vaginoceras belemnitiforme* Holm. Nat. size..... p. 36

Longitudinal section, showing the tapering of shell, the ectoseptal distances and the position and the size of the endoconch.

Loc:—Near Ta-fang village, Yang-sin-hsien, E. Hupeh. (G.S.C. Cat. No. 2835)

Fig. 9. *Vaginoceras neichianense* Yü. Nat. size..... p. 39

9a. Longitudinal section, showing the ectoseptal distances, the rate of tapering and the endoconch with the stereoplasmic filling.

9b. Cross section.

Loc:—Near Sin-tan, Tze-kuei-hsien, W. Hupeh. (G.S.C. Cat. No. 2836)

Fig. 10. *Vaginoceras reedi* Yü. Nat. size..... p. 40

10a. Portion of a weathered individual, showing the ectoconch with a part of endoconch exposed.

10b. Longitudinal section of same, showing the closely set ectosepta and the entirely empty endoconch.

10c. End view of same, showing the form and position of endoconch.

Loc:—Near Sin-tan, Tze-kuei-hsien, W. Hupeh. (G.S.C. Cat. No. 2838)

Fig. 11. *Vaginoceras reedi* Yü. Nat. size..... p. 40

11a. Longitudinal section of a portion of the shell, showing the size of endoconch and the ectoseptal distances.

11b. Cross section.

Loc:—Near Sin-tan, Tze-kuei-hsien, W. Hupeh. (G.S.C. Cat. No. 2839)

EXPLANATION OF

PLATE II

PLATE II.

Fig. 1. *Cameroceras tenuiseptum* Hall var. *ellipticum* Yü. Nat. size..... p. 24

Polished section, showing the endotheca, size of endoconch, and the closely set ectosepta.

Loc:—Nei-chia-shan, near Sin-tan, Tze-kuei-hsien, W. Hupeh. (G.S.C. Cat. No. 2829)

Fig. 2. *Cameroceras tenuiseptum* Hall var. *ellipticum* Yü. Nat. size..... p. 24

View of a portion of specimen weathered so as to show the protruding endoconch.

Loc:—Nei-chia-shan near Sin-tan, Tze-kuei-hsien, W. Hupeh. (G.S.C. Cat. No. 2830)

Fig. 3. *Cameroceras* sp. Nat. size..... p. 27

Polished section of a fragment of the specimen. The endotheca is clearly shown.

Loc:—Near Sin-tan, Tze-kuei-hsien, W. Hupeh. (G.S.C. Cat. No. 2833)

Fig. 4. *Endoceras grabaui* Yü. Nat. size..... p. 29

A natural weathered section, showing the length of tubi, the last endoseptum and endocone.

Loc:—Shih-lung-sze, Wang-chia-chi, I-chang-hsien, N. Hupeh. (N.R.I. Cat. No. 3)

Fig. 5. *Vaginoceras endocylindricum* Yü. Nat. size ..... p. 33

5a. External view of a natural weathered specimen, showing the rate of tapering and the ectosepta.

5b. Longitudinal section, showing the long empty endocylinder. The section is taken nearly normal to the dorso-ventral diameter of the shell.

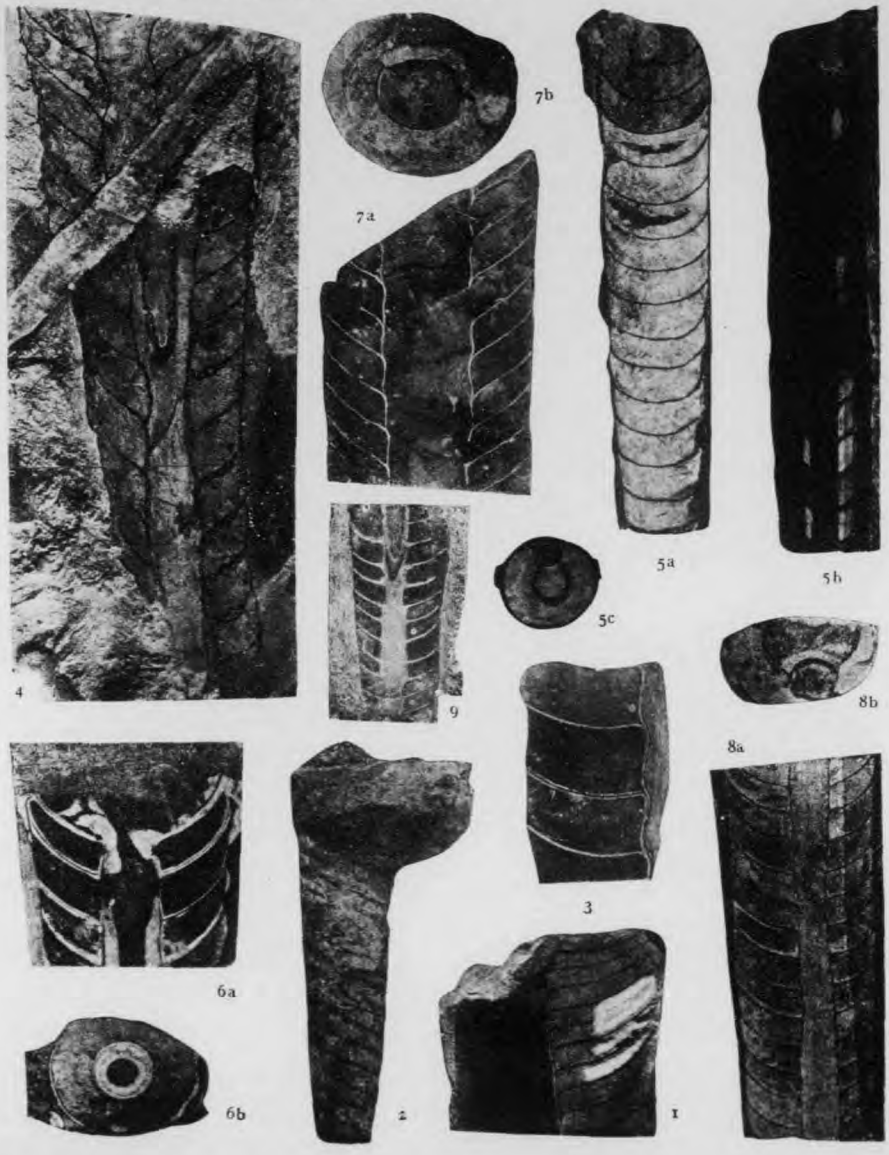
5c. Cross section of same, showing the form of ectoconch and the position, form and size of endoconch.

Loc:—Near Ta-fang village, Yang-sin-hsien, E. Hupeh. (G.S.C. Cat. No. 2834)

Fig. 6. *Vaginoceras neichianense* Yü. Nat. size..... p. 39

6a. Longitudinal section of the large end of a shell with the last endoseptum and endocone.

C. C. Yü: Ordovician Cephalopoda of Central China Pl. II.



6b. Cross section, showing the position and form of endoconch, and the shape of endocone.

Loc:—San-shan-yuan, Chung-yang-hsien, SE. Hupeh. (N. R. I. Cat. No. 13)

Fig. 7. *Vaginoceras neichianense* Yü. Nat. size..... p. 39

7a. Polished section of the superior part of the specimen, showing the endocylinder and the ectosepta with a very small amount of stereoplasmic deposit.

7b. Cross section, showing the form and position of endoconch.

Loc:—Near Sin-tan, Tze-kuei-hsien, W. Hupeh. (G.S.C. Cat. No. 2837)

Fig. 8. *Vaginoceras uniforme* Yü. Nat. size..... p. 42

8a. Longitudinal section of a mature portion of a shell showing the uniform ectoseptal distances and the rate of tapering.

8b. Cross section, showing the form of the marginal endoconch.

Loc:—San-shan-yuan, Chung-yang-hsien, SE. Hupeh. (N. R. I. Cat. No. 14)

Fig 9. *Vaginoceras uniforme* Yü. Nat. size..... p. 42

Longitudinal section of a fragment of the specimen. showing the ectoseptal distances and the size of endoconch.

Loc:—San-shan-yuan, Chung-yang-hsien, SE. Hupeh. (N. R. I. Cat. No. 15)

EXPLANATION OF

PLATE III

PLATE III.

Fig. 1. *Vaginoceras wahlenbergi* Foord. $\times\frac{1}{2}$ ..... p. 30

1a. A natural polished section, showing the rate of tapering and the ectoseptal distances of the borken lower portion of the specimen.

1b. Longitudinal section, showing the endoconch, the endocylinder, and the ectosepta. The section is transverse to the dorso-ventral diameter of the shell.

Loc:—Tai-hung-shan, Nan-chang-hsien, N. Hupeh. (N.R.I. Cat No. 4)

Fig. 2. *Vaginoceras endocylindricum* Yü. $\times\frac{7}{10}$ ..... p. 33

2a. A natural section, showing the rate of tapering.

2b. Cross section at the stage f of the same specimen, showing the forms of ectoconch and the submarginal endoconch.

2c. Longitudinal section of a fragmentary portion of the same shell, showing the long endocylinder, endocone and the last endoseptum.

2d. Cross section at the stage h of same, showing the submarginal endoconch with a very small endosiphuncle at its middle part.

Loc:—Ta-wu-shu, Chung-yang-hsien, SE. Hupeh. (N.R.I. Cat. No. 7)

Fig. 3. *Vaginoceras endocylindricum* Yü. Nat. size..... p. 33

3a. View of a natural section weathered so as to show a part of the endoconch preserved at the apical part of the fragment.

3b. Cross section at the lower end of the shell, showing the form of ectoconch and the position of the endoconch.

Loc:—Ta-wu-shu, Chung-yang-hsien, SE. Hupeh. (N.R.I. Cat. No. 8)

Fig. 4. *Vaginoceras giganteum* Yü. $\times\frac{1}{2}$ ..... p. 45

4a. Natural polished section, showing the rate of tapering, the depth of septa and the endoconch. The endoconch at the middle part of the specimen has been partly weathered away.

4b. Cross section with an excentric endoconch.

Loc:—Ta-wu-shu, Chung-yang-hsien, SE. Hupeh. (N.R.I. Cat. No. 16)

Fig. 5. *Orthoceras chinense* Foord. Nat. size..... p. 46

5a. Longitudinal section, showing the length of septal necks, the depth of cameræ and the rate of tapering.

5b. Cross section, showing the position of the rounded siphuncle.

Loc:—Near Sin-tan, Tze-kuei-hsien, W. Hupeh. (G.S.C. Cat. No. 2843)

C. C. Yü: Ordovician Cephalopoda of Central China

Pl. III.

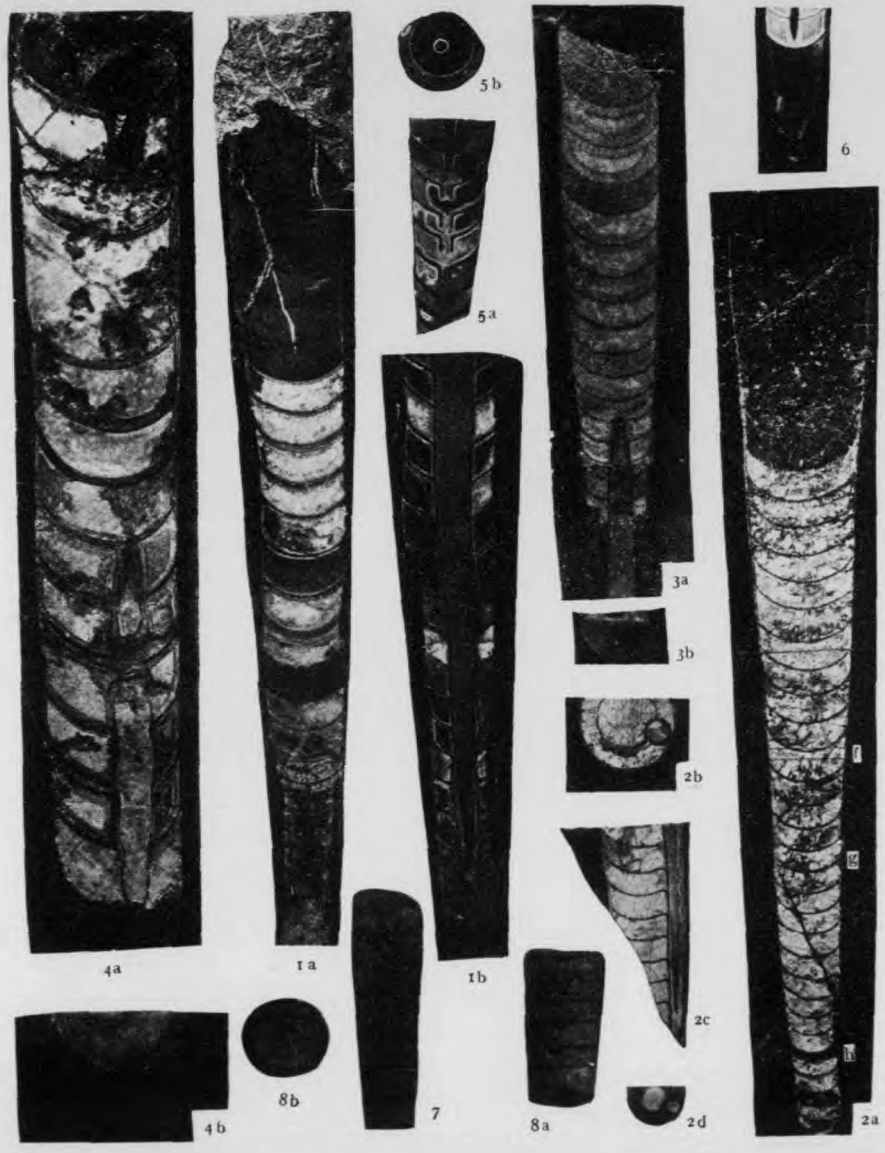


Fig. 6. *Orthoceras* cf. *politum* M'Coy. Nat. size..... p. 52

A natural weathered section with a part of siphuncle preserved at the upper end of the specimen.

Loc:—Ta-hung-shan, Nan-chang-hsien, N. Hupeh. (N.R.I. Cat. No. 32)

Fig. 7. *Orthoceras yangtzeense* Yü. Nat. size..... p. 59

External view of an internal mould of the shell, showing the V-shaped lobes formed by the septal sutures.

Loc:—Near Sin-tan, Tze-kuei-hsien, W. Hupeh. (G.S.C. Cat. No. 2851)

Fig. 8. *Orthoceras yangtzeense* Yü. Nat. size..... p. 59

8a. External view of an internal mould, showing the V-shaped lobes.

8b. End view of the same specimen, showing the size and form of the submarginal siphuncle at the opposite side of the V-shaped lobes.

Loc:—Near Sin-tan, Tze-kuei-hsien, W. Hupeh. (G.S.C. Cat. No. 2852)

EXPLANATION OF

PLATE IV

PLATE IV.

Fig. 1. *Vaginoceras wahlenbergi* Foord var. *cylindrica* Yü. Nat. size..... p. 32

Longitudinal section, showing the endocylinder, the ectosepta and the rate of tapering.

Loc:—He-chiao, Chung-yang-hsien, SE. Hupeh. (N. R. I. Cat. No. 5)

Fig. 2. *Vaginoceras wahlenbergi* Foord var. *cylindrica* Yü. Nat. size..... p. 32

2a. Natural polished section, showing the rate of tapering and the depth of ectosepta.

2b. Longitudinal section with a large endocylinder. The section does not pass through the middle part of the endocylinder in the upper part of the specimen.

Loc:—Liu-chia-sze, Hsien-ning-hsien, SE. Hupeh. (N.R.I. Cat. No. 6)

Fig. 3. *Vaginoceras shui* Yü. Nat. size..... p. 37

3a. A natural polished longitudinal section, showing the very long tubi, endosepta, depth of ectosepta and the rate of tapering.

3b. Cross section with a submarginal endoconch.

Loc:—Wang-chia-sze, Chung-yang-hsien, SE. Hupeh. (N. R. I. Cat. No. 11)

Fig. 4. *Orthoceras chinense* Foord. Nat. size..... p. 46

4a. Longitudinal section, showing the tapering, the septal necks and the depth of camerae.

4b. Cross section, showing the form of shell and the size of the central, circular siphuncle.

Loc:—Near Sin-tan, Tze-kuei-hsien, W. Hupeh. (G.S.C. Cat No 2844)

Fig. 5. *Orthoceras regulare* Schlotheim. Nat. size..... p. 52

Longitudinal section, showing the septal necks, septal distances and the rate of tapering.

Loc:—Near Sin-tan, Tze-kuei-hsien, W. Hupeh. (G.S.C. Cat. No. 2848)

Fig. 6. *Orthoceras regulare* Schlotheim. Nat. size..... p. 52

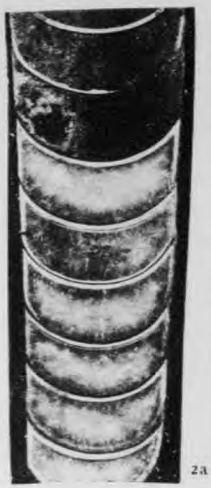
6a. Longitudinal section, showing the tapering, the septa and septal necks.

6b. Cross section, showing the form of shell and the position of siphuncle.

Loc:—Near Sin-tan, Tze-kuei-hsien, W. Hupeh. (G.S.C. Cat. No. 2849)

Fig. 7. *Orthoceras squamatulum* Barrande. Nat. size..... p. 53

C. C. Yü: Ordovician Cephalopoda of Central China Pl. IV.


2a


2b


4a


3b


3a


4b


6a


6b


8c


5


8a


7b


1


7a


8b

7a. Longitudinal section, showing the deep cameræ, the short septal necks and the gentle rate of tapering.

7b. Cross section.

Loc:—Near Sin-tan, Tze-kuei-hsien, W. Hupeh. (G.S.C. Cat. No. 2850)

Fig. 8. *Orthoceras rudum* Yü. Nat. size..... p. 55

8a. Longitudinal section, showing the septal necks and the septal distances.

8b. External view of the same specimen, showing the lines of growth.

8c. Cross section.

Loc:—Near He-chiao, Chung-yang-hsien, SE. Hupeh. (N. R. I. Cat. No. 26)

EXPLANATION OF

PLATE V

PLATE V.

Fig. 1. *Vaginoceras peiyangense* Yü. $\times \frac{1}{2}$ ..... p. 35

1a. Natural polished section, showing the rate of tapering and the ectoseptal distances.

1b. Longitudinal section of the broken apical portion of the same specimen, showing the endoconch and the endocylinder. The section is slightly oblique to the dorso-ventral diameter.

Loc:—Pei-yang-shan, Chung-yang-hsien, SE. Hupeh. (N. R. I. Cat. No. 9)

Fig. 2. *Vaginoceras peiyangense* Yü. Nat. size..... p. 35

2a. Longitudinal section with a portion of endoconch and some tubi adhering to it at the lower part of the specimen.

2b. Cross section, showing the position and form of endoconch.

Loc:—He-chiao, Chung-yang-hsien, SE. Hupeh. (N.R.I. Cat. No. 10)

Fig. 3. *Vaginoceras chientzekouense* Yü. Nat. size..... p. 38

Longitudinal section, showing the endocylinder and the ectosepta. The section is nearly normal to the dorso-ventral diameter of the shell.

Loc:—Chien-tze-kou, Nan-chang-hsien, N. Hupeh. (N.R.I. Cat. No. 12)

Fig. 4. *Vaginoceras uniforme* Yü. Nat. size..... p. 42

4a. Longitudinal section, showing the uniformity of the ectoseptal distances.

4b. Cross section with a submarginal endoconch.

Loc:—Near Ta-fang village, Yang-sin-hsien, E. Hupeh. (G.S.C. Cat. No. 2840)

Fig. 5. *Vaginoceras multiplectoseptatum* Yü. Nat. size..... p. 44

Longitudinal section, showing the numerous ectosepta and the marginal endoconch.

Loc.:—Near Sin-tan, Tze-kuei-hsien, W. Hupeh. (G.S.C. Cat. No. 2841)

Fig. 6. *Vaginoceras multiplectoseptatum* Yü. Nat. size..... p. 44

External view of a weathered specimen, showing the multiple ectoseptal sutures and the rate of tapering.

Loc:—Near Sin-tan. Tze-kuei-hsien, W. Hupeh. (G.S.C. Cat. No. 2842)

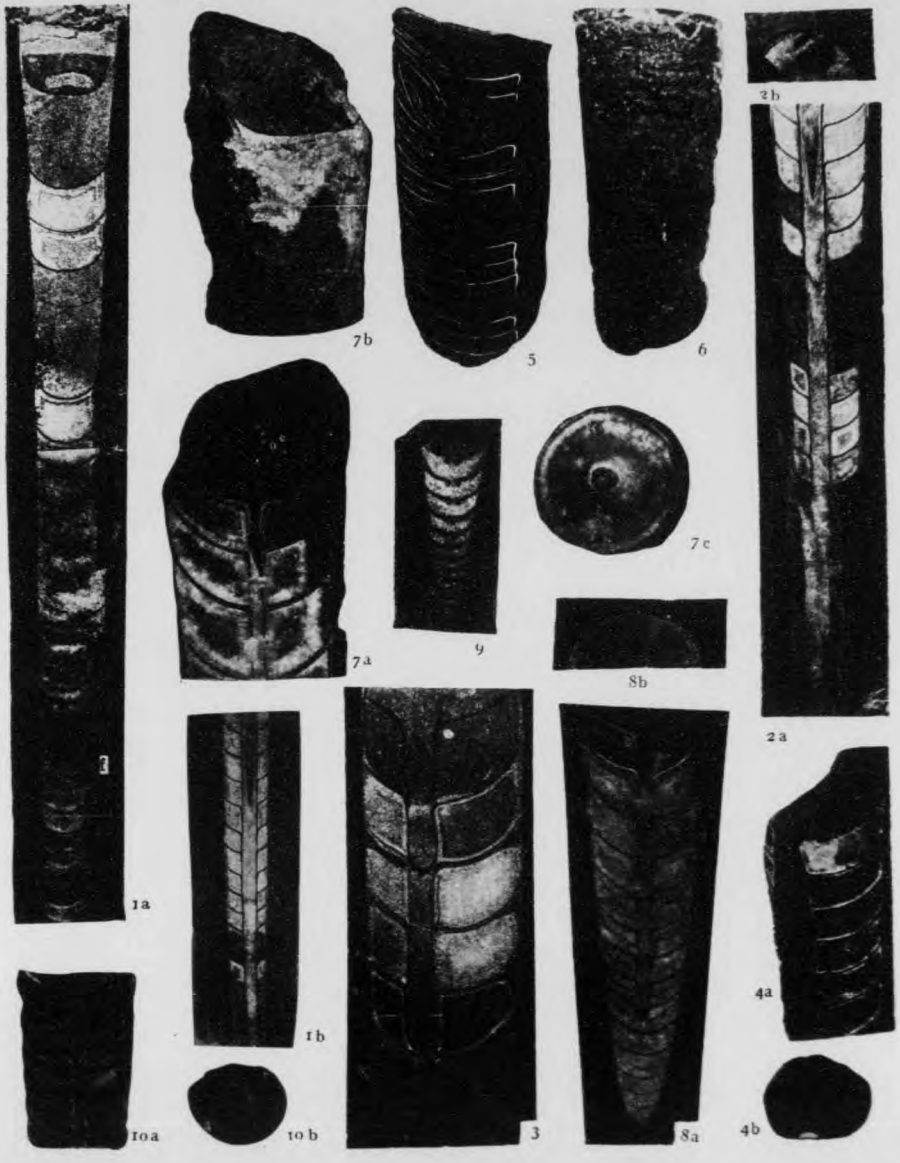

1a
7b
5
6
2b
2a
7a
9
7c
8b
1b
3
8a
4a
10a
10b
4b

Fig. 7. *Orthoceras chinense* Foord. Nat. size..... p. 46

7a. Longitudinal section of the large end of the shell, showing the septal necks, septal distances and rate of tapering.

7b. External view of same. The regular, flexuous, transverse striæ are plainly shown.

7c. Cross section, showing the form of the shell and the position of the siphuncle.

Loc:—Near Sin-tan, Tze-kuei-hsien, W. Hupeh. (G.S.C. Cat. No. 2845)

Fig. 8. *Orthoceras sumi* Yü. Nat. size..... p. 56

8a. Longitudinal section of the apical portion of the specimen, showing the rate of tapering and septal distances.

8b. Cross section, showing the sub-elliptical form of shell and the position of the siphuncle.

Loc.:—Pei-yang-shan, Chung-yang-hsien, SE. Hupeh. (N. R. I. Cat. No. 29)

Fig. 9. *Orthoceras sumi* Yü. Nat. size..... p. 56

Natural section, showing the rate of tapering, septal necks and the depth of cameræ.

Loc:—Pei-yang-shan, Chung-yang-hsien, SE. Hupeh. (N. R. I. Cat. No. 30)

Fig. 10. *Orthoceras? wongi* Yü. Nat. size..... p. 60

10a. Longitudinal section, showing the continuous septal necks.

10b. Cross section, showing the forms of both the shell and the siphuncle.

Loc:—Near Sin-tan, Tze-kuei-hsien, W. Hupeh. (G.S.C. Cat. No. 2853)

EXPLANATION OF

PLATE VI

PLATE VI.

Fig. 1. *Orthoceras chinense* Foord. Nat. size..... p. 46

1a. Longitudinal section showing the septal necks, septal distances and rate of tapering.

1b. Cross section, with a central rounded siphuncle.

Loc:—Lo-jo-ping, I-chang-hsien. W. Hupeh. (G. S. C. Cat. No. 2846)

Fig. 2. *Orthoceras chinense* Foord. Nat. size..... p. 46

2a. Longitudinal section, showing the rate of tapering and septal distances.

2b. External view of same, showing the fine transverse striæ.

2c. Cross section. The small dark ring is not a siphuncle. It is formed by cutting the septa just above the septal neck.

Loc:—Tai-hung-shan, Nan-chang-hsien, N. Hupeh. (N.R.I. Cat. No. 17)

Fig. 3. *Orthoceras densum* Yü. Nat. size..... p. 58

3a. Longitudinal section, showing the very crowded septa at the apical portion of the shell.

3b. Cross section.

Loc:—Chien-tze-kou, Nan-chang-hsien, N. Hupeh. (N.R.I. Cat. No. 27)

Fig. 4. *Protocycloceras deprati* Reed. Nat. size..... p. 62

4a. Front view of an internal mould, showing the annulations and the rate of tapering.

4b. Lateral view of same, showing the annulations arched on the backside.

Loc:—Near Sin-tan, Tze-kuei-hsien, W. Hupeh. (G.S.C. Cat. No. 2854)

Fig. 5. *Protocycloceras deprati* Reed. Nat. size..... p. 62

External view of a portion of the mould with fine striæ on the annulations and the interspaces between them.

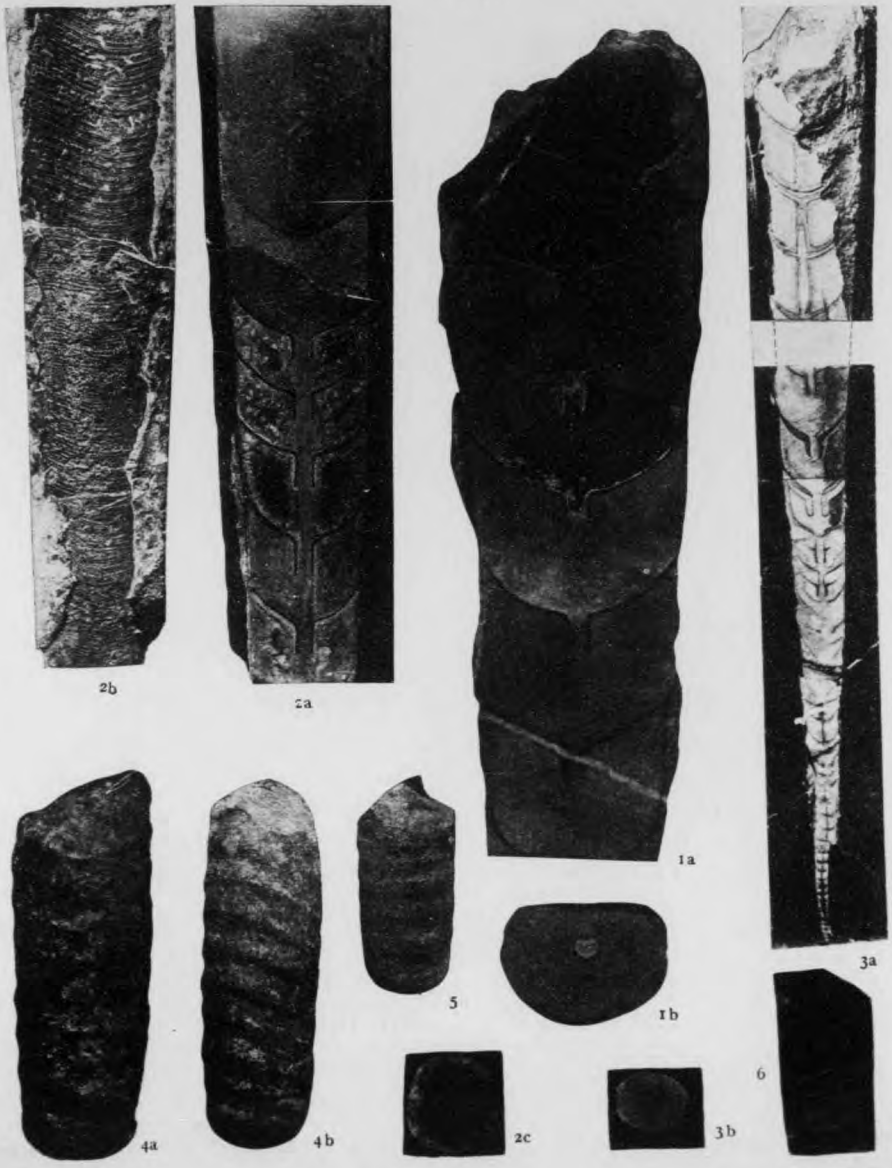
Loc:—Near Sin-tan, Tze-kuei-hsien, W. Hupeh. (G.S.C. Cat. No.2855)

Fig. 6. *Cycloceras* sp. Nat. size..... p 63

Portion of a mould, showing the oblique annulations and the longitudinal and transverse striæ near the upper end of the fragment.

Loc:—Tai-hung-shan, Nan-chang-hsien, N. Hupeh. (N.R.I. Cat. No. 35)

C. C. Yü: Ordovician Cephalopoda of Central China Pl. VI.



EXPLANATION OF

PLATE VII

PLATE VII.

Fig. 1. *Orthoceras chinense* Foord var. *kuangchiaoense* Yü. Nat. size..... p. 48

1a. Polished section, showing the septal distances and the rate of tapering. The last camera below the living chamber is free from any deposit.

1b. External view of the same, showing the growth-lines.

1c. Cross section.

Loc:—Near Chiang-chia-chi, Kuang-chiao-pu, King-shan-hsien, N. Hupeh. (N.R.I. Cat. No. 19)

Fig. 2. *Orthoceras chinense* Foord var. *kuangchiaoense* Yü. $\times \frac{1}{5}$ ..... p. 48

A natural weathered section, showing the rate of tapering and the septal distances.

Loc:—Near Wang-chia-sze, Chung-yang-hsien, SE. Hupeh. (N. R. I. Cat. No. 20)

Fig. 3. *Orthoceras thyrsus*? Barrande. Nat. size..... p. 54

3a. Longitudinal section of a superior portion, showing the rate of tapering, septal necks and the septal distances.

3b. Cross section.

Loc:—Near Sin-tan, Tze-kuei-hsien, W. Hupeh. (G.S.C. Cat. No. 2847)

Fig. 4. *Orthoceras remotum* Yü. Nat. size..... p. 54

4a. A natural polished section, showing the depth of camerae, the concavity of septa and the rate of tapering.

4b. Cross section, showing the form of shell and the position of siphuncle.

Loc:—Chai-tze-shan, Hsiang-yang-hsien, N. Hupeh. (N. R. I. Cat. No. 25)

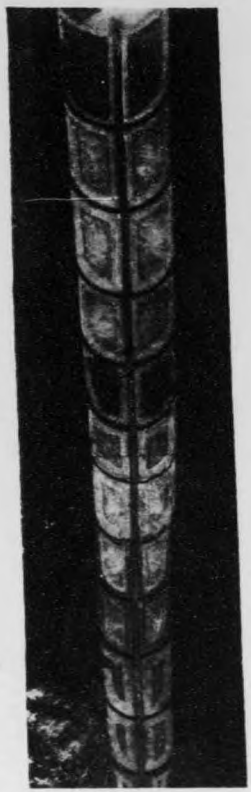
Fig. 5. *Orthoceras elongatum* Yü. Nat. size..... p. 57

Longitudinal section, showing the long septal distances and the rate of tapering.

Loc.:—Ta-wu-shu, Chung-yang-hsien, SE. Hupeh. (N.R.I. Cat. No. 31)

C. C. Yü: Ordovician Cephalopoda of Central China

Pl. VII.



1a

1c

1b

2

PLATE VII.

1. *Orthoceras chinense* Foord var. *kuangchiaoense* Yü. Nat. size..... p. 48

1a. Polished section, showing the septal distances and the rate of tapering. The last camera below the living chamber is free from any deposit.

1b. External view of the same, showing the growth-lines.

1c. Cross section.

Loc:—Near Chiang-chia-chi, Kuang-chiao-pu, King-shan-hsien, N. Hupeh. (N.R.I. Cat. No. 19)

2. *Orthoceras chinense* Foord var. *kuangchiaoense* Yü. $\times \frac{1}{5}$ ..... p. 48

A natural weathered section, showing the rate of tapering and the septal distances.

Loc:—Near Wang-chia-sze, Chung-yang-hsien, SE. Hupeh. (N. R. I. Cat. No. 20)

3. *Orthoceras thyrsus*? Barrande. Nat. size..... p. 54

3a. Longitudinal section of a superior portion, showing the rate of tapering, septal necks and the septal distances.

3b. Cross section.

Loc:—Near Sin-tan, Tze-kuei-hsien, W. Hupeh. (G.S.C. Cat. No. 2847)

4. *Orthoceras remotum* Yü. Nat. size..... p. 54

4a. A natural polished section, showing the depth of camerae, the concavity of septa and the rate of tapering.

4b. Cross section, showing the form of shell and the position of siphuncle.

Loc:—Chai-tze-shan, Hsiang-yang-hsien, N. Hupeh. (N. R. I. Cat. No. 25)

5. *Orthoceras elongatum* Yü. Nat. size..... p. 57

Longitudinal section, showing the long septal distances and the rate of tapering.

Loc.:—Ta-wu-shu, Chung-yang-hsien, SE. Hupeh. (N.R.I. Cat. No. 31)

C. C. Yü: Ordovician Cephalopoda of Central China

4a

4b

5

1a

1c

1b

3b

2

3a

4a

4b

5

1a

1c

1b

3b

2

3a

EXPLANATION OF

PLATE VIII

PLATE VIII.

Fig. 1. *Vaginoceras*? sp. $\times\frac{2}{5}$ ..... p. 45

External view of an internal mould embedded in rock with sharp impressed annular lines on its surface.

Loc:—Pei-hu-pu, Pu-chi-hsien, SE. Hupeh. (N.R.I. Cat. No. 35)

Fig. 2. *Orthoceras chinense* Foord var. *eccentrica* Yü. Nat. size..... p. 49

Longitudinal section, showing the excentric siphuncle, the rate of tapering and the septal distances.

Loc:—Wang-chia-sze, Chung-yang hsien, SE. Hupeh. (N. R. I. Cat. No. 18)

Fig. 3. *Orthoceras chinense* Foord var. *equiseptatum* Yü. Nat. size..... p. 50

Natural polished section, showing the septal necks and the nearly equidistant septa toward the apertural end.

Loc:—Pei-hua-pu, Pu-chi-hsien, SE. Hupeh. (N.R.I. Cat No. 21)

Fig. 4. *Orthoceras chinense* Foord var. *equiseptatum* Yü. Nat. size..... p. 50

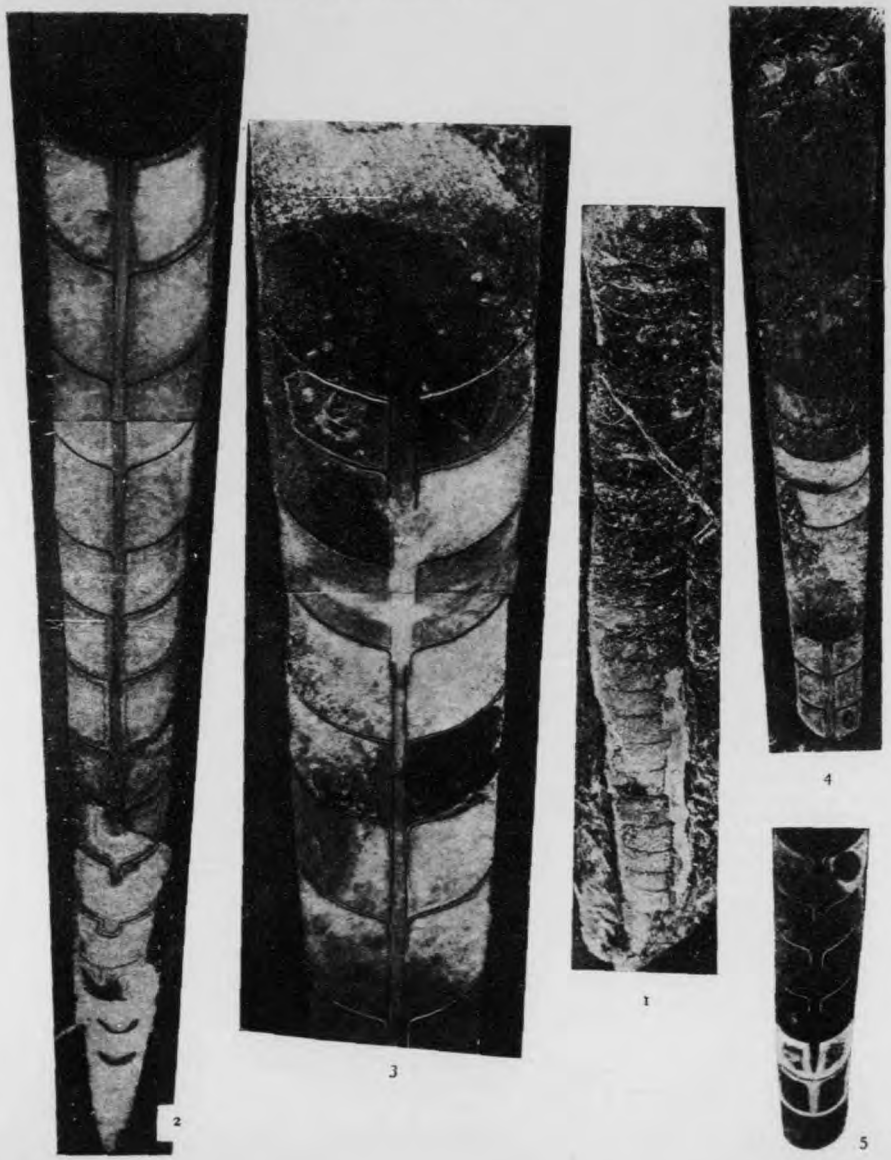
A natural section weathered so as to show a part of siphuncle and the septal distances.

Loc:—Pei-hua-pu, Pu-chi-hsien, SE. Hupeh. (N.R.I. Cat. No. 22)

Fig. 5. *Orthoceras chinense* Foord var. *equiseptatum* Yü. Nat. size..... p. 50

Longitudinal section, showing the septal distances and the septal necks.

Loc:—Mei-hua-ling, Tung-chiao-cheng, King-shan-hsien, N. Hupeh. (N.R.I Cat. No. 23)



1

2

3

4

5

EXPLANATION OF

PLATE IX

PLATE IX.

Fig. 1. *Orthoceras chinense* Foord var. *equiseptatum* Yü. Nat. size..... p. 50

1a. Longitudinal section, showing the septal distances and the septal necks.

1b. Cross section, with a central circular siphuncle.

Loc:—Heh-chia-tzui-tze, Chang-chia-chi, Chung-chei-hsien, N. Hupeh. (N.R.I. Cat. No. 24)

Fig. 2. *Orthoceras densum* Yü. Nat. size..... p. 58

A natural weathered section of a young stage of the shell, showing the numerous septa at the apical portion.

Loc:—Lin-chia-chung, Kung-chia-wang, I-cheng, N. Hupeh. (N.R.I. Cat. No. 28)

Fig. 3. *Orthoceras* sp. Nat. size..... p. 60

Lateral view of the specimen, showing the oblique septal sutures.

Loc.:—Pei-ting-tze, Hu-chia-chi, Chung-hsiang-hsien, N. Hupeh. (N.R.I. Cat. No. 33)

Fig. 4. *Orthoceras* sp. Nat. size..... p. 61

A natural polished section. The siphuncle has been completely eroded away.

Loc:—Between Cha-ti-pu and Chang-chia-chiao, Hsien-ning-hsien, SE. Hupeh. (N.R.I. Cat. No. 34)

Fig. 5. *Discoceras eurasiaticum* Frech. Nat. size..... p. 64

Side view of a characteristic shell, showing the costæ on the surface of the shell and the septal sutures as exposed at the last half volution where the test has been broken away.

Loc:—Nei-chia-shan near Sin-tan, Tze-kuei-hsien, W. Hupeh. (G.S.C. Cat. No. 2856)

Fig. 6. *Discoceras eurasiaticum* Frech. Nat. size..... p. 64

6a. Side view of a small specimen, showing the volutions and the costæ on the surface of the shell.

6b. Transverse section of same, showing the whorls subquadrate in section and the siphuncle marginal to the internal side. The section is taken across the middle part of the umbilicus.

Loc:—Nei-chia-shan near Sin-tan, Tze-kuei-hsien, W. Hupeh. (G.S.C. Cat. No. 2857)

C. C. Yü: Ordovician Cephalopoda of Central China Pl. IX.

Fig. 7. *Lituites? lii* Yü. Nat. size..... p. 65

Side view of natural section, showing the separable volutions, the straight part of the shell and the position of siphuncle.

Loc:—He-chiao, Chung-yang-hsien, SE. Hupeh. (N.R.I. Cat. No. 36)

Fig. 8. *Meloceras asiaticum* Yabe. Nat. size..... p. 66

Lateral view of a large end of the specimen, showing the curvature of the shell.

Loc:—Nei-chia-shan, near Sin-tan, Tze-kuei-hsien, W. Hupeh. (G.S.C. Cat. No. 2858)

Fig 9. *Meloceras asiaticum* Yabe. Nat. size..... p. 66

9a. Longitudinal section of an apical portion of the specimen along the dorso-ventral diameter, showing the empty, marginal siphuncle and the curvature of the shell.

9b. External view of same, showing the surface striæ.

9c. Cross section, showing the form of the shell and the position of the siphuncle.

Loc:—Nei-chia-shan near Sin-tan, Tze-kuei-hsien, W. Hupeh. (G.S.C. Cat. No. 2859)

4. 直角石 Orthoceras　外殼多爲長直形，體管小，其位置常居中，或微偏，壁襞短，外壁平滑，或具生長紋。（本屬共有十七種）

5. 原環節角石 Protocycloceras　形爲直角石狀，或弓角石狀，外壁具環節，幼殼或有直紋可見，體管大。（本屬只有一種）

6. 環節石角 Cycloceras　外殼頗似上屬，有不連續的直紋，至老年，環節漸消失。（本屬僅一種，因標本破碎，種名未能定。）

7. 薇石 Lituites　幼時形似盤角石，至中年，螺環忽鬆弛，成直角石狀，殼之口緣，常呈突起及低凹之象。（歸本屬者一種）

8. 盤角石 Discoceras　螺環皆依平面螺旋，彼此接觸，成鸚鵡螺狀，螺環放大頗速，外壁有凸狀脊，向後灣曲，與梯板方向相反，體管位置多在螺環內緣。（本屬僅一種）

9. 瓜角石 Meloceras　外殼爲弓角石狀，兩側微扁壓，體管似鏈狀，口部開張，其斷面長圓，畧具三角形。（本屬有一種）

爲最特殊，而產量亦極豐富，至中部及西南部，除日本野田氏在湖北與山縣得一未定種名之珠角石外，其他各地，則未一見其踪跡。(2) 中國南部施甸所產中奧陶紀之標準頭足類化石，如 Vaginoceras(Endoceras)wahlenbergi Foord, Orthoceras regulare Schl., Protocycloceras deprati Reed 等，復得之於湖北艾家山層。(3) 本篇所研究各種屬中，除 Cameroceras tenuiseptatum Hall var. ellipticum Yü, Cameroceras hsiehi Yü 數種，可與北美出產者相比較外，餘則極近似歐洲相當時期之頭足類動物，雖盡非同種，而重要性質，實多相同之處。葛利普先生近謂中國及歐洲之奧陶紀動物，均源出印度洋，自海水浸入大陸後，東向直入中國克薩與大內斜 Cathaysian geosyncline 之南部，西則經喜馬拉雅大內斜 Himalayan geosyncline 而達西歐，並遙下奧陶紀筆石之分佈，以証明之。如引葛氏之說，則中國中部（湖北等處）之中奧陶紀頭足類，與西南部及西歐相當時期之頭足類種類所以相似之深，而與屬 Boreal Province 之中國北部及北美種類之所以有別，蓋亦有故矣。

六，頭足類各屬概說

本篇所論頭足類化石，凡九屬四十二種。茲將各屬特殊性質，畧述於次，至各種重要之點，請觀原文。

1. 璧角石 Cameroceras 外殼爲直角石狀，內殼甚大，中充內梯板，有內髓管貫穿其間，璧襟長約達一氣房。具內璧，爲本屬動物之特徵。（歸本屬者有五種）
2. 內角石 Endoceras 殼之構造，似璧角石，但無內璧，璧襟長度，僅及一氣房，內梯板甚少。（本屬有二種）
3. 鞘角石 Vaginoceras 大致與內角石彷彿，惟璧襟特長，每越前外梯板而下伸，內梯板亦較多。（歸本屬者凡十二種）

a. 蒲縹

Orthoceras sp.

b. Lameng

Orthoceras sp.

c. 施甸

Endoceras wahlenbergi Foord
Endoceras cf. cancellatum Eichow
Endoceras aff. reinhardi Boll.
Orthoceras regulare Schl.
Orthoceras cf. kinnekullense Foord
Orthoceras cf. scabrium Ang.
Orthoceras (Protocycloceras ?) deprati Reed
Actinoceras cf. bigsbyi Brown
Jovellania sp.
Cameroceras ? sp.
Cyrtoceras sp.
Spyrocoras ? sp.
Trocholites yunnanensis Reed
T. aff. macromphalus Schröd
Lituites sp.
Taephyceras ? sp.

由上述中國各處之奧陶紀頭足類化石觀之可注意之點有三。(1) 中國北部中奧陶紀之頭足類以珠角石

Cyrtoceras (Meloceras) asiaticum Yabe

c. 東湖縣之 No-lu-ping （華名未詳）有志留紀岩層，層下爲灰色土質石灰岩，含頭足類化石，以層位及岩石性質測之，或卽艾家山系。（採集者日本 Usui）

Lituites (Ancistroceras) Angelini Boll. var.

Discoceras eurasiaticum Frech

Discoceras sp. undt.

Orthoceras sp. undt.

Orthoceras sp. undt.

d. 李仲揆教授謝劉趙季舒諸先生及著者，在湖北各地之艾家山系及下奧陶紀所獲之頭足類化石，已分述於前，茲不復贅。

7. 四川　威理士等經過川境大寧河之徐家壩，發現化石於中奧陶紀之雞心嶺石灰岩頂部，中有頭足類化石一種，魏雷氏鑑定之。

Vaginoceras sp.

8. 黔川間　四川綦江縣揚哥老與貴州酒店埡之間，日本 Yamada 採有頭足類二種。

Orthoceras chinense Foord

Orthoceras sp.

9. 雲南　本省西部產中奧陶紀化石者，計有三處，蒲縹，施甸，及 Lameng。（華名未詳）施甸爲產頭足類化石特多之地，據鑑定人李特氏 Reed 之意見，謂施甸頭足類化石層之時期，實相當於俄波羅的海省之鞘角石石灰岩，或斯堪察加及波羅的海省之海刺球石灰岩。

5. 江蘇

a. 佛萊希氏謂崙山石灰岩之化石與鄂西所產 Orthoceras chinense Foord, Discoceras eurasiaticum Frech 等之地史時期相同屬上奧陶紀。（現知確屬中奧陶紀）彼鑑定化石中有頭足類一種。

Endoceras duplex Wahlenberg

b. 徐淵摩先生調查鎮江高資一帶地質採有頭足類二種於崙山，據葛利普先生之觀察謂爲下奧陶紀之動物與李希霍芬氏在崙山所得者種屬迥不相同，究竟兩者是否來自同層，尙待他日之覆勘。

Proterocameroceras mathieui Grabau

Suecoceras attenuatum Grabau

6. 湖北　鄂省地質迭被中外地質家所測勘，頭足類化石之發見有如下列。

a. 李希霍芬氏在長江三峽及宜昌北東湖縣之中奧陶紀採獲下述各種。（佛萊希氏鑑定）

Orthoceras chinense Foord

Cyrtoceras (Meloceras) cfr. ellipticum Lossen

Lituites (Ancistroceras) angelini Boll.

Discoceras verbecki Frech

Discoceras eurasiaticum Frech

b. 日本野田氏在興山縣戶溪播子垭等處得有下列化石，該處岩層爲棕色泥質石灰岩，殆卽鄂西之艾家山系。

Actinoceras (Ormoceras) sp. undt.

Orthoceras chinense Foord

b. 佛萊希氏稱英國陳列館內有上奧陶紀標本數種，只知來自山東，而眞確地點不可考，此類化石，或亦與高林氏所採得者同層歟。

Actinoceras sp.

Trochoceras sp.

c. 威理士氏及布賴克韋塔氏在糙米店，新太縣東南，耿家庄東北，顏庄西南等處，及濟南附近之濟南石灰岩（中奧陶紀）層中，均尋有頭足類化石，經魏雷氏（Weller）鑑定，謂爲同屬之直角石。（其種名缺。）

Orthoceras sp.

d. 丁文江先生法地質家馬球氏（Mathieu）及地質調查所採集如左。（葛利普先生鑑定）

Stereoplasmoceras pseudoseptatum Grabau

Stereoplasmoceras machiakouense Grabau

Actinoceras richthofeni Frech

Actinoceras tani Grabau

Actinoceras coulingi Grabau

Actinoceras suanpanoides Grabau

Actinoceras curvatum Grabau

Cyrtactinoceras frechi Grabau

Gonioceras shantungense Grabau

4. 河南　涉縣馬家溝石灰岩產有珠角石一種。

Actinoceras coulingi Grabau

Cameroceras styliforme Grabau
Chihlioceras nathani Grabau
Chihlioceras chingwangtaoense Grabau
Piloceras platyventrum Grabau
Suecoceras yehliense Grabau
Suecoceras attenuatum Grabau

b. 黃汲清先生在北平西山奧陶紀層中採有下列各種。

(a) 馬家溝石灰岩

Stereoplasmoceras pseudoseptatum Grabau
Actinoceras coulingi Grabau
Actinoceras suanpanoides Grabau

(b) 白祿亭石灰岩

Proterocameroceras minor Grabau
Proterocameroceras mathieui Grabau
Piloceras platyventrum Grabau
Chihlioceras nathani Grabau
Chihlioceras sp.

3. 山東　本省奧陶紀頭足類化石，數經採集，有如左列。

a. 高林氏 (Couling) 在膠州得有頭足類一種，由克理格氏 (Crick) 鑑定之，葛利普先生謂仍屬馬家溝石灰岩時期，並修正該化石之種名。（附於原名右方括弧內）

Actinoceras (Ormoceras) aff. teniufilum Hall (=A. coulingi Grabau)
Gonioceras sp. . . . . (cf. G. shantungense Grabau)

Actinoceras murakamii Kobayashi
Cyrtactinoceras mitsuishii Kobayashi
Discoactinoceras multiplexum Kobayashi
Cyrtoceras (Meloceras) aff. asiaticum Yabe

2. 河北

a. 北平地質調查所及其他學者於河北省各處之下奧陶紀及馬家溝石灰岩中採集之多頭足類化石經葛利普先生鑑定其種類如下。

(a) 馬家溝石灰岩

Vaginoceras tsinanense Grabau
Cycloceras ? peitoutzeense Grabau
Steroplasmoceras pseudoseptatum Grabau
Stereoplasmoceras machiakouense Grabau
Stereoplasmoceras actinoceriforme Grabau
Actinoceras richthofeni Frech
Actinoceras tani Grabau
Actinoceras coulingi Grabau
Actinoceras submarginale Grabau
Actinoceras nanum Grabau
Cyrtactinoceras frechi Grabau

(b) 下奧陶紀石灰岩

Proterocameroceras mathieui Grabau

a. 德地質家李希霍芬氏於遼寧太子河畔之小市 (Hsiau-sörr) 得有下列頭足類化石一種，經佛萊希氏 (Frech) 之鑑定，謂屬上奧陶紀，現葛利普先生認爲與河北馬家溝石灰岩之時期相當。

Actinoceras richthofeni Frech

b. 一九二八年經日本 Kobayashi 鑑定之頭足類化石，有如下列，均採自遼寧之豆房溝牛心臺等處，時代與馬家溝石灰岩同。

Cyclocerας (?) peitoutzense Grabau
Stereoplasmoceras pseudoseptatum Grabau
Stereoplasmoceras submarginale Kobayashi
Stereoplasmoceras subcentrale Kobayashi
Tofangoceras pauciannulatum Kobayashi
Tofangoceras irregulare Kobayashi
Actinoceras richthofeni Frech
Actinoceras tani Grabau
Actinoceras coulingi Grabau
Actinoceras manchurense Kobayashi
Actinoceras submarginale Grabau
Actinoceras nanum Grabau
Actinoceras harioi Kobayashi
Actinoceras suanpanoides Grabau
Actinoceras curvatum Grabau

Illaenus nanchangensis Sun
Bathyurus minor Sun
Bronteus sp.

四，宜昌石灰岩及艾家山層之地史時期

昔李仲揆教授於鄂西宜昌石灰岩中所得之化石數種，均來自該層頂部，經葛利普先生之鑑定，知屬下奧陶紀。惟該層下部，含有古珊瑚化石，其時期則論者不一，日本古生物家矢部長克根據化石上之性質，謝家榮先生根據地層上之關係，均以爲應屬寒武紀，但葛利普先生仍疑爲下奧陶紀。舒文博先生及著者往鄂北調查時，於本層下部，亦復未獲其他之標準化石，是此問題之解決，仍須待諸異日。

艾家山系之時期，多謂爲中奧陶紀或上奧陶紀之下部。余等在鄂北調查，至南漳縣西三里之太紅山，除於本系上部採集極多之頭足類化石外，更自下部發現極多之三叶虫筆石腕足等類化石。筆石標本保存完善，纖維可見，爲前人在鄂調查所未發現者。其種名 Didymograptus murchisoni Beck，與英國藍特羅 (Llandielo) 之冒氏叉筆石層 (D. murchisoni zone) 爲同時之停積。至於上部之時期，由所產之頭足類化石証之，與瑞典之直角石灰岩及俄波羅的海省之鞘角石灰岩正復相同。

五，湖北奧陶紀頭足類動物之來源

奧陶紀頭足類化石，我國北部及西南部均有之。在中部所見本類動物化石，來自北部乎，抑源出西南部乎。欲知其究竟，請先舉前人在我國各地奧陶紀中所採頭足類化石之種屬如次。

1. 東三省

量最多之 Triplecia (Yangtzella) poloi Martelli。此方則未一見。殆搜尋未力。抑另有他故歟。本層所採化石列後。

a. 艾家山層上部之化石

Endoceras grabaui Yü
Vaginoceras (Endoceras) wahlenbergi Foord
Vaginoceras chientzekouense Yü
Orthoceras chinense Foord var. kuangchiaoense Yü
Orthoceras chinense Foord var. equiseptatum Yü
Orthoceras cf. politum M'coy
Orthoceras remotum Yü
Orthoceras densum Yü
Orthoceras sp.
Cycloceras sp.

b. 艾家山層下部之化石

Didymograptus murchisoni Beck
Orthis calligramma Dalm.
Dalmanella sp.
Leperditia sp.
Asaphus hupehensis Sun
Tailungshania shui Sun

Vaginoceras peiyangense Yü

Vaginoceras shui Yü

Vaginoceras neichiangense Yü

Vaginoceras uniforme Yü

Vaginoceras giganteum Yü

Vaginoceras sp.

Orthoceras chinense Foord var. eccentrica Yü

Orthoceras chinense Foord var. equiseptatum Yü

Orthoceras rudum Yü

Orthoceras suni Yü

Orthoceras elongatum Yü

Orthoceras sp.

Lituites iii Yü

4.

鄂北　鄂北與陶紀地層與鄂西大致相同。下爲厚逾一〇〇〇米之宜昌石灰岩。上爲艾家山層。後者層薄。厚約八〇米。更分二部。下部爲黃綠色頁岩。上爲淡綠色泥質石灰岩。本層分佈極廣。如南漳宜城鍾祥京山及襄陽之南境。莫不有其踪跡。其上部含頭足類化石之多。正不減鄂西之產量。中外學者見鄂產直角石狀之頭足類化石。輒以寶塔石呼之。而名爲 Orthoceras chinense Foord。實則內含全角石類及直角石類。種屬紛歧。固未可以一概百也。下部頁岩中。亦產有多量之三葉虫腕足筆石等類化石。惟鄂西產

2. 鄂東　日本野田勢次郎(Noda)曾至東南一帶調查，文載支那地學調查報告第二卷。一九二三年秋，謝劉兩先生至陽新等縣察看地質，方悉野田氏昔日調查之失精確。查陽新等處奧陶紀之停積，爲灰色石灰岩。因初見於陽新大阪村，遂以村名名之爲大阪石灰岩。其頂部有紫色灰質頁岩一層，厚二〇米，內產頭足類臍足類及三叶虫等化石。視化石性質，此層之地質時代，殆與鄂西艾家山系上部相當。化石有下列各種。

Vaginoceras belemnitiforme Holm

Vaginoceras endocylindricum Yü

Vaginoceras uniforme Yü

Orthoceras chinense Foord

3. 鄂東南部　李捷先生調查蒲圻崇陽等縣地質，謂奧陶紀停積物出露於地面者，殆全爲石灰岩所組成。由岩石性質言之，可分爲二部。下爲深灰色之厚層石灰岩，約五〇〇米。上部則爲紅色薄層狀石灰岩與灰質頁岩之互層，厚一四〇米。其底另有一層三〇米厚之黃灰色薄層石灰岩。頭足類化石，出自上部之底層者特多。按此處上部岩石之性質雖與鄂西艾家山系有別，但由化石之種屬觀之，與艾家山層及大阪石灰岩頂部所產相同者，尙屬不少，然則此上部岩層之時期，殆亦與艾家山系相當歟。各種化石，有如左列。

Endoceras leei Yü

Vaginoceras wahlenbergi Foord var. cylindrica Yü

李仲揆教授採得頭足類化石原存北大地質標本室現僅餘數種合謝趙兩先生所採獲者其類別如下。

a. 宜昌石灰岩

Cameroceras cf. styliforme Grabau

b. 艾家山系（上部）

Cameroceras tenuiseptum Hall var. ellipticum Yü

Cameroceras hsiehi Yü

Cameroceras subtile Yü

Cameroceras sp.

Vaginoceras meichianense Yü

Vaginoceras reedi Yü

Vaginoceras multiplectoseptatum Yü

Orthoceras chinense Foord

Orthoceras regulare Schlotheim

Orthoceras squamatulum Barrande

Orthoceras thyrsus? Barrande

Orthoceras yangtzeense Yü

Orthoceras? wongi Yü

Protocycloceras deprati Reed

Discoceras eurasiaticum Frech

Meloceras asiaticum Yabe

寧河畔雞心嶺及鄂西宜昌上之南沱等處見有極厚層石灰岩直覆於南沱冰磧層之上其在南沱者厚達一千二百米名曰雞心嶺石灰岩歸之於寒武奧陶紀本層之頂部另有一綠色灰質頁岩與結核狀石灰岩相間之岩層厚約六十餘米再上則爲志留紀之新灘系一九二四年春李仲揆教授曾赴長江三峽一帶作精密之調查發現威理士氏等所稱之雞心嶺石灰岩不僅代表寒武及奧陶兩時期之岩層更有葛利普氏所稱震旦紀之停積亦且包括其中於是廢雞心嶺石灰岩之舊名而另名寒武奧陶兩紀岩層爲牛肝系以示與下部之震旦紀有別復於牛肝系下部尋有寒武紀三葉虫化石乃再將本系所含寒武及奧陶兩紀岩層實行劃開下者曰石牌頁岩厚二〇〇米化石有 Redlichia chinensis Walcott, Obolus sp. 屬下寒武紀上部曰宜昌石灰岩及艾家山系屬奧陶紀與石牌頁岩爲不連續宜昌石灰岩厚約一一五〇米至一六八〇米內有下奧陶紀化石如 Callograptus cf salteri Hall, Proterocameroceras mathieui Grabau, Eccyliopterus sp, Asaphus sp, Archaeocyathus chililiensis Grabau, Girvanella sinensis Yabe 等類艾家山系厚度爲一一〇米可分兩部下部爲綠色灰質頁岩及棕黃或淡灰色石灰岩之互層如 Triplecia (Yangtzella) poloi Martelli, Clitambonites giraldii Martelli 爲其中最特別之化石上部爲灰色石灰岩含頭足化石極夥由本系中所得化石計有 Triplecia (Yangtzella) poloi Martelli, Clitambonites giraldii Martelli, Orthis calligramma Dalm., Eccyliopterus sinensis Frech, Vaginoceras duplex Wahlenberg, Discoceras eurasiaticum Frech, Endoceras sp, Cyclo-ceras sp., Cyrtoceras sp., Asaphus cf expansus Dalm. 等一九二四年秋謝趙兩先生再至鄂西調查並及奧陶紀岩層與李仲揆教授所見者相同

葛氏新創名稱		其他學者習用名稱
外殼	Ectoconch.	..Shell (Exclusive of siphuncle)
內殼	Endoconch.	..Siphuncle
外壁	Ectotheca.	..Shell wall
內壁	Endotheca.	..Endosiphonlining (often absent)
外梯板	Ectosepta.	..Septa
內梯板	Endosepta.	..Endosiphosheaths
壁襟	Tubus (pl. Tubi)	..Septal funnels
內體管	Endosiphuncle.	..Endosiphuncle
內體房	Endocone.	..Endosiphocone
內圓管	Endocylinder.	..Endosiphocylinder

三，湖北各處奧陶紀岩層之比較

湖北西境及東南之地質，業經李仲揆教授及謝家榮劉季辰趙亞曾諸先生先後測勘。十七年，李捷舒文博兩先生及著者復分赴崇陽蒲圻及鄂北諸縣調查。關於產生頭足類鸚鵡螺類化石之奧陶紀停積物，在西北者似與東南畧有不同之點。茲將各處奧陶紀岩層，（註一）簡述於次，以資比較。

1. 鄂西　一九〇三年，美人威理士 (Willis) 及布賴克韋塔 (Blackwelder) 來我國調查地質，經過川境大

註一。一九二五春，謝劉兩先生至湖北西南部調查。一九二八秋，孟慈民先生至遠安當陽等縣調查。所述奧陶紀岩層，大致與鄂西相同，以未採集多量頭足類化石，故從略。

復不少、所受侵蝕程度、殊較崇陽及鄂北採得者爲深。李仲揆教授採集之標本、存北京大學地質標本室。謝趙兩先生所採集者、則儲地質調查所古生物研究室中。承吾師葛利普博士之命、將是項材料、併取而研究之。

北京大學教授葛利普博士、對著者之研究、指導良多。中央地質研究所所長李仲揆教授亦復多所指示。中國地質調查所所長翁詠霓博士與著者以研究上之種種便利。中國古生物誌編輯丁在君博士孫鐵仙博士亦嘗有所關注。許光熙計榮森二先生任攝影之勞。均識於此、藉表謝忱。

二、頭足類鸚鵡螺類化石構造名稱

本類化石、具外殼。其形不一、或爲直角石狀、或爲弓角石狀、有爲環角石狀、平面螺旋、螺環互相離開、有爲鸚鵡螺狀、螺環接觸、其後者且抱圍前者。殼之成於胚胎時者、曰始原殼。迨漸長而內具梯板者、曰體殼。體殼內含梯板若干、橫分全殼爲若干氣房。最後較大者曰體房、爲動物生活時收納肉體之處。有管狀小孔、穿過各梯板、是爲體管、其位置則視種類而異。梯板沿體管周圍、突向後曲折伸張、作漏斗狀。是爲壁襟。直角石類之壁襟甚短、全角石類之壁襟則甚長。

全角石類體管較大、內部充以圓錐形之石灰質薄板、另有一更小管狀孔、直貫其中。本類中有名壁角石者、其體管周圍、更有一層覆被物、遮蔽於壁襟裏面。葛利普先生最近主張、謂全角石類之體管、可相當於直角石類之體殼、前者體管周圍之覆被物及圓錐形之石灰質薄板、各相當於後者之殼（註一）及梯板。遂另立新名、以名全角石類動物化石之各部。本篇關於全角石類化石、採用名詞、即葛氏所新創者。茲將新名臚列於左、附之以其他學者所習用之原名、以便讀者。有所比較焉。

註一。此殼係狹義的，專指殼之外壁（Shell wall）而言。

中國中部奧陶紀頭足類化石

俞建章著

一，引言

十七年五月，湖北建設廳石衡青先生電請地質研究所派員赴鄂調查地質礦產。李捷舒文博兩先生先至蒲圻嘉魚一帶測勘煤田，余因事後往，約會咸寧。至則李舒二先生方留崇陽調查，余乃趁暇在余家山一帶採集志留紀之三葉虫等類化石。時李舒二先生亦於崇陽採集多量之頭足類鸚鵡螺類化石，其長者約達一公尺，余以標本美麗可觀，遂先取而研究焉。

是年十月，舒文博先生與余再應約至鄂北調查。爲時不及三月，計經六縣，南漳宜城襄陽荆門鍾祥京山等是。在本區域內，各地史時代，均有相當之停積物。（鄂北一帶泥盆紀石英岩上多覆以含 Tetrapora, Schwagerina 之石灰岩，當時以其性質頗與南京棲霞系相似，遂歸之於上石炭紀，現葛利普博士謂棲霞系應屬下二疊紀，然則石炭紀岩層，在鄂北等處，殆已全部缺失歟。）所採化石，以中奧陶紀下志留紀下二疊紀諸時期爲最豐富。其分佈最廣，產量最多，星羅碁布，觸目皆是者，厥爲艾家山系上部（中奧陶紀）之頭足類鸚鵡螺類化石。惟因行程匆促，未遑多事採集，至今思之，猶有餘憾。

初，謝家榮劉季辰兩先生曾於陽新縣大阪石灰岩頂部，採有頭足類化石數種。十三年春，李仲揆教授率北大同學赴長江上游宜昌秭歸間考察地質，於艾家山系上部，復得有甚多之頭足類標本。是年秋，謝趙兩先生再至宜昌巴東一帶調查，所得頭足類化石更夥，惟標本保存不甚完整，僅存內殼者（Endocone）有之，全爲內模型者（Internal mould）亦有之，其表面略具外殼之形態，而內部則爲凝結之泥土，原有構造蕩然無存者，亦

古生物誌乙種第一號

第二册

中國中部奧陶紀頭足類化石

俞建章 著

（學術研究與國立中央研究院合作）

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俞建章著

中華民國十九年