

UPPER PALÆOZOIC FORMATIONS AND FAUNAS OF YAOLING,
CHENHSIEN, S. HUNAN.

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STRATIGRAPHY

Yao Ling (瑶林) lies 40 li southeast from Chen Hsien city (郴縣), about Long. $112^{\circ}30'$ E., Lat. $25^{\circ}40'$ N., and is halfway between Chen Hsien city and the well known wolfram mining district, Yao Kang Sien (瑶崗仙). On the whole, Yao Ling is a mountainous region, situated on the southeastern slope of Wu Kai Shan (五蓋山), one of the ranges of the Nanling system (南嶺山脈). The region studied covers, however, only the south part of Yaoling and the area is very small, about 15 li from south to north and several li from east to west. Almost all the hills and mountains of this region were visited one after the other, but my attention is concentrated only along the stream and the fossils found are therefore mostly from the localities along it. This is because the rocks, not only the shales and sandstones of the coal series but even the limestones, are not well exposed in the soil-covered hills and mountains. Furthermore, wherever the limestone is well exposed its weathered surfaces are almost completely covered by mosses. This feature is generally characteristic of the southern provinces of China, so that the fossils are not easily found in such outcrops. But the structure of the rocks and the fossil-bearing beds are well-exposed along the streams, by which they have been cut and washed.

The topographic feature of this region is in the mature to late mature stage; the hill ranges are more or less rounded and mostly covered by soil and vegetation. The relatively high ranges are built up by two series of limestones and the relief therefore clearly shows the character of the rocks. The river has for the most part a v-shaped valley; the running direction of it is principally across and only focally along the strikes, and it sometimes under-cuts the bank and produces a precipitous slope.

The names of the formations are derived from the type localities where the formations are well exposed and fossils are abundantly found. In descending order the formations as embodied in this paper are as follows:

Carboniferous	{	Taikuei Formation or Upper Limestone
to Permian		Shihertu coal series or Upper coal series
Disconformity?		

Carboniferous { Shihertulung Formation or Lower Limestone
Pengkungling Coal Series or Lower Coal Series

Pengkungling Coal Series

This series is 450 meters thick, excluding the unexposed base. It is composed mainly of sandstone, gray shales and black shale with three or four seams of coal, anthracite and bituminous, which is mined in native pits. The mean thickness of each seam is $1\frac{1}{2}$ to 2 meters.

Since the base is not exposed, the relation with the underlying rocks is unknown, but the latter can be seen at a distance from Pengkungling coal pit from which the name of this series is derived, and they seem to be a kind of sandstone, red, purple and gray in color. So far no fossils have been found in this series.

Shihertulung Formation

These limestones are well exposed at Shih Er Tu Lung, from which the name of this formation is taken. They are exposed especially along the valley, where they are commonly under-cut and form rather high cliffs. The whole formation is not less than 700 meters thick, but from the lithological character of the rocks and the richness of different fossils, they may be divided into two parts or groups. There are however no sharp dividing lines but the beds merge gradually into each other.

The lower part of the formation is rich in fossil corals, both simple and compound ones, but the latter are more prominent. These compound corals are always attractive to the geologist because of their natural sections. Sometimes a whole mass—*Thysanophyllum*—is found lying upon the beds just like an old Chinese musical instrument, the Sheng (笙). Each of the corallites is like a bamboo strip of that instrument; and the wonderful likeness to it is that occasionally the outer cystose zone is removed, showing the transverse ring-like 'ribs' of the palp apparently corresponding to the nodes of the bamboo. Simple coral fossils are scattered here and there, and because of the different colors of corals they stand out clearly to the eyes of fossil hunters. On the other hand the limestone is rich in foraminifera, such as *neofusulinella*, etc. Probably the limestone was wholly built up by these kinds of foraminifera. The limestones are deep black in color, massive and rather hard; the thickness of this part is about two-fifths to one-third of the formation. The fossils collected include the following:

Heterocarinia tholusitabulata Yabe and Hayasaka. (4)*

Neofusulinella cf. *bocki* Möller (4)

Thysanophyllum circulocysticum Chu (sp. nov.) (4)

Siphonodendron yaolingense Chu (sp. nov.) (3)

Bellerophon sp.....(2-4)

The upper part of the formation contains few coral fossils or only fragments; the large simple and compound corals have disappeared or have so far not been found. But the formation is rich in gastropoda, especially of the genus *Bellerophon*, and these fossils always appear in thin beds which vary from a few inches up to several feet thick, and they are intercalated with the massive and thick layers of limestone. In the *Bellerophon*-bearing beds are usually present fragments of coral fossils and of cephalopods. About ten or more beds of this kind persist for a considerable distance, from which we may identify the beds at one place with those at another or at one limb of a syncline or an anticline with that of the other limb. The interspaces of these beds are from several meters to thirty or forty meters. From this fact we may easily imagine that during the time of the deposition of this part of limestone the water body was not constantly maintained in the same conditions throughout, but frequently changed, and these were very apparently periodic changes; namely at one time the conditions were suitable for the organisms, thus they were well developed. After a certain interval the conditions changed, for instance the salinity of the water body increased; the temperature changed, etc. and then the close coiling gastropod, *Bellerophon* and other organisms were killed. Consequently all the dead animals sinking to the bottom accompanied the limestone deposits. After another interval of time the conditions again changed, and again most probably because similar to those under which the ancestors of the organism were developed, we find them appearing again. Since changes of conditions have repeatedly taken place as a result we have the deposits again and again. In this part of limestone *Bellerophon* and *Actinoceras* suddenly appear again and at the same time the foraminifera and corals are very few. These facts lead one to imagine that between the latest deposition of the lower part and the very beginning of the upper part of this formation there must have been a great change of conditions, though no break is found in the field, for probably the interval was very short. The fossils found in this part of limestone are:

*No. of fossil localities showing in the map.

<i>Bellerophon</i> sp.	(5-10)
<i>Actinoceras?</i> sp.	(5)
<i>Bellerophon</i> sp.	(6)
<i>Syringopora</i> cf. <i>hyperbolatabulata</i> Yoh (?)	(9)

The whole formation is folded into a series of synclines and anticlines, but these are of a minor scale, the width of the comparatively large syncline and anticline being about 120 meters or greater, and that of the smaller syncline and anticline 10 to 20 meters only. This formation is conformable with the preceding coal series, i. e. Pengkungling coal series, but it is probably disconformable with the upper i. e. Shihertu coal series.

Shihertu Coal Series

This series consists of alternating beds of black and gray shales, buff sandstone, and quartz-sandstone intercalated with five or six coal seams, which are mined in native pits everywhere along the strikes. But the coal is lignitic and bituminous and is not as good as that in the lower coal series.

The relation of this series is probably disconformable with the preceding formation. The break has not been found in the field, because the contact is not exposed due to the covering of soil everywhere. The fact which leads me to imagine the existence of a hiatus between them is that in the valley of Shih Er Tu Lung, at the southwestern slope of the hill of this series there is a sandstone pebble, very similar to the buff sandstone of this series, which consists of a fragment of rather large simple coral fossil, its longest diameter being about 1½ inches and being moderately flexed to a horn-shape. The matrix of the coral fossil in the pebble is very similar to the preceding limestone. Unfortunately this coral has not yet been studied as it was lost in travelling. Nevertheless, since we may judge it by the possible conditions and the lithological character rather than the study of fossil, we may assume that this sandstone pebble is not the same sandstone as that of this series but merely similar to it. But the coral fossil is a specimen eroded and disintegrated from the lower limestone. This is indicated by the fact that the valley is one of only a very small stream in the uppermost part and most probably the source of the stream water is hardly beyond the Lower coal series, i. e. Pengkungling coal series. And therefore the stream running from the very beginning to this coal series passes through the Pengkungling coal series and Shihertulung formation only, among which the coral bearing beds are the latter formation underlying this coal series. So that I think before the depositing of this series the underlying limestone had at least

a certain time of erosion and disintegration which produced a pebble of that coral fossil. That means there is a more or less hiatus between them. This, however, is a minute witness. The problem should be left to further research. Fossils so far being found are fragments of plant fossils. One of them belongs to the genus *Lepidodendron*.

Taikuei formation.

This formation is conformable with the preceding coal series i. e. Shihertu coal series. In some places (fossil locality No. 12) a very small lens of coal, about several square inches long and one-fourth or more thick, is just underlying a compound coral fossil and the limestone containing this coral is very black, even as black as coal; and the coral itself, especially its epitheca has a coal-like appearance.

This limestone formation differing with the Shihertulung formation lithologically is the massive limestone intercalated with thin beds. Other curious features in the massive limestone beds are that the weathering surfaces of one stratum or two commonly 1 to 3 or 4 meters thick, are very black in color and some parts of it being more resistant to the weathering than the others, produce the small ridges which often incline in a certain direction, as if a heap of snow had partially melted on the sunny side. These black limestones at first sight may be easily mistaken for chert, but if you try to break and examine them the material is not different from other parts of limestone, as to hardness, color, etc. but occasionally the outer layer is rather white like calcite. This limestone formation, as a whole, is rich in coral fossils but wherever this black substance occurs in the outcrops there is no coral but only one kind of algae fossils, which is somewhat like *Collenia*. It is generally from one inch to five or six inches in diameter, and commonly lies transversely to the beds. Otherwise there is a scarcity of other fossils or a complete absence of them wherever the algae fossil-bearing beds are present. On the other hand, in the limestone a kind of breccia structure often occurs on a very small scale, being several square meters in a natural section and restricted to one place or another only, but not in beds. The angular fragments are of three different sizes and forms, the largest ones being more or less square in section, diameters about 3 to 5 inches, larger ones commonly triangular in form, main width 1 to 2 or 3 inches, and the rest very minute, form about 5% of the whole mass. Both the fragments and the matrix are made up by the same material, that is lime the same as the adjacent rocks. This breccia may be a kind of friction breccia caused by local mechanical stress, and the fragments are those which were broken *in situ*.

There is still one fact concerning this formation which should be mentioned here. On the middle of the northeastern limb of the syncline (near fossil locality no. 17), a kind of conglomeratic limestone, unlike that of the Cambrian rock of N. China, is rather characteristic; the pebbles and matrix are both limestones but the former are sometimes found with an outer zone of calcite. The pebbles are elongated and may be recognised in the field, though the weathered surface does not show them well. Sometimes this feature is clearly seen in the paving stone of the road nearby the outcrops. The short diameter of the pebbles is about 2 or 3 to 5 mm., the longer one being about 10 or 15 to 20 mm. The arrangement of them is more or less parallel to the beds, but it is common to find them making an angle.

Far to the north of this formation the limestone was intruded on by a large mass of granite. By the process of the intrusion there were formed mineral deposits, which include galena, arsenopyrite, pyrite and bismuth ore. At another region (near fossil locality no. 15) an antimony sulphide ore deposit occurs. This deposit is probably due to the same process as galena, etc., but is located at a distance from the granite.

The thickness of this formation is not less than one thousand meters from the lowest bed to the highest bed of the syncline, but the real thickness of it is unknown, because the upper part of the syncline has been eroded away.

The fossils so far found in this formation are:

<i>Lithostrotion</i> sp	(18)
<i>Siphonodendron yaolingense</i> Chu	(15)
<i>Wentzelella</i> (?) sp.....	(14, 15)
<i>Fusulina?</i> sp.....	(13)
<i>Siphonodendron hunanense</i> Chu	(12)
<i>Lonsdaleia?</i> sp.....	(12)
<i>Syringopora</i> sp	(12)
<i>Bellerophon</i> sp	(12)

AGE AND CONCLUSION

Concerning the age of the formations studied it is hardly possible to correlate them definitely with any of the known formations of the Carboniferous in China or because the successions of deposit and the lithological characters are different from them, and the fossils are rather scanty and mostly new. But by the palaeontological study, especially of coral fossils which show distinct affinities with the Lower Carboniferous forms, the Shihertulung formation and its underlying Pengkungling coal series are most probably of the Dinantian or L. Carboniferous age. The

Shihertu coal series which is disconformable with the lower limestone, and Taikuei formation are the middle to upper Carboniferous and it seems that the upper part of the Taikuei formation belongs to Permian, though the fossils found in the lower part are Carboniferous forms or their affinities.

DESCRIPTIONS OF FOSSILS

SIPHONODENDRON

Siphonodendron yaolingense Chū (sp. nov.)

Plate II, fig. 1a, 1b, 2a, 2b.

Description : — Corallum fasciculate. Corallites very tall; sub-cylindrical, generally somewhat tapering toward the base at a rate of about 1 in 10 mm.; slightly flexuous and often coalescent. The interspace between corallites is as large as the corallite or greater. Epitheca thin, sometimes showing septal grooves. Calyx unknown, but cross-sections show it to have been more or less circular. Very generally one corallite joins the neighbouring ones by the development of one or two arm-like connecting stolons.

The diameter of the cross-section varies from 4 mm. to 7 mm. The length of the corallites is unknown. Columella present from very early stage of the corallite to adult, thin and much compressed; it is really a pseudocolumella formed by the prolongation of one of the primary septa to the center, this being assumed as the counter septum. Commonly the columella is still continuous with one or both opposing septa, these being regarded as the counter and cardinal septum respectively. In this condition it is difficult to distinguish which is a counter and which a cardinal septum. But the former is often found in the younger stage and the latter almost always occurs in the mature and older stages.

Septa thin, straight or slightly curved, but flexuous in young corallites and often one septum connecting with the other crosses the center or subcentral parts. At this stage the columella has as yet not appeared or can not be clearly seen. They are rather closely set, the principal ones (18 in young corallites, 20 to 22 in the adult) including the four primaries, reaching almost to the center of the tabulae. There is generally a distinct sclerotheca formed of dissepiments and a central flat area shows in the cross-section, which is about $1/7$ to $1/5$ the diameter of the entire corallite. In some cases (fig. 1a) only the cardinal and counter septa extend beyond the sclerotheca; in other cases several septa and in still others they irregularly extend beyond it and to the pseudo-columella. Tertiary septa do not extend far from the epithecal wall, reaching scarcely or not at all beyond the pseudo-columella formed of the cysts. Few dissepiments occur

between septa. Cysts always restricted to the outer part of the circumference of the corallite; in longitudinal section we can see that cysts on either side take up almost one-fifth the width of it, forming a pseudo-inner wall which is clearly shown in cross-sections. They are arranged generally in a single row just lying upon the epitheca, but double rows or even one overlapping two or three preceding ones by accelerated growth are common. Tabulae are well developed, placed about one-half a millimeter apart, lying obliquely to the columella making an angle of about 45° to 70° , and more or less irregular in arrangement.

Entire corallite filled with stereoplastic deposit but in particular cases it is restricted to one portion only. Where absent the septa can be clearly seen. Both septa and cysts, and even the tabulae are slightly thickened by stereoplasm. Occasionally an irregular stereoplastic deposit is also seen in longitudinal sections.

Another specimen, collected from the lower limestone i.e. Shihertulung formation, has the following characteristics: corallum fasciculate, small, about 8 to 10 mm. in diameter, generally flexuous, tall and subcylindrical; epitheca thin; calyx unknown. Outer surfaces of the corallites show the presence of growth lines with moderate wrinkles indicating a slight expansion and contraction, and on the weathered surface of epitheca the longitudinal and parallel arrangement of septa can be clearly seen. The corallites are much like the one described before, being frequently in contact with one another. The internal structure is also similar to that one, but there are certain differences. The septa are moderately thick but thin towards the center, rather closely set and radial. They generally reach near the center leaving a very small flat area which is circumscribed by an apparent sclerotheca. The latter is more prominent in that one and less in the present specimen. Principal septa number 24 to 26 and the tertiaries are very short and do not extend beyond the pseudo-inner wall. The dissepiments and cysts are like those of the one before described. But the dissepiments are always concave to the center unlike those in the one described, which are gently concave or even flat and restricted to the central portion only. The arrangement of cysts in this specimen is almost always in two or even three layers as is seen in longitudinal section and they are thickened.

Comparison—This coral is similar to *Lithostrotion caespitosum* Mart (p. 15, Tab. II. Fig. 1, Mémoires du Comité Géologique De Russie, Nouvelle Série, Livraison 175—1923.), but the epitheca of the present form is thinner, and some features of the inner structures are different. It is also similar to

Lithostrotion martini Edwards and Haimé (Brit. fossil corals from the Mountain Limestone p. 197, pl. 40, fig. 2), but differs from it in having the tabulae less flat and less regularly arranged, and both cysts and pseudo-columella differ in some respects. There is still a similar form, *Lithostrotion irregulare* Ph. var. *asiatica* Yabe & Hayasaka (Paleozoic Corals from Japan, Korea and China, Atlas of Fossils pl. X, fig. 2a-b). The present form is distinguished from the latter by having (1) the corallite provided with a larger number of septa; (2) the relatively shorter tertiary septa—in this respect, as they are described, the present form agrees quite well with typical *L. irregulare* Phill—and (3) less dense and flat tabulae.

Horizon and Locality—Taikuei formation, Permo-Carboniferous; collected from Yeh Ya Tang (野鴨塘), (fossil locality No. 15), Chen Hsien, S. Hunan.

Shihertulung formation, Carboniferous; collected from Shih Er-Tu Lung, (fossil locality No. 3) (十二度壩) of the same district.

***Siphonodendron hunanense* Chu (sp. nov.)**

(Pl. II, fig. 3a-3b)

Description—Corallum fasciculate, individual corallites growing one after the other, forming a chain-like structure and circumscribing a certain space which in section appears as a more or less ill-defined rectangular area. Since the corallites are so near to each other and, in some cases, even touching one another, individual parts sometimes assume a prismatic form; that is, a tendency toward hexagonal shape, but some retain their subcylindrical or even cylindrical forms, when they do not touch each other.

Epitheca thin. Septa radial, rather loose and more or less irregular toward the center. They are thin but thicker towards the periphery, wherein the thickness is the same as that of the epitheca. Principal septa (primary and secondary) are 14 to 18 with the same number of tertiaries. All of them scarcely reach the center but the principal ones extend about two-thirds the way from the periphery to the center, where in conjunction with the tabulae they form apparently a pseudo-inner wall by the cut edge of their surface as seen in cross-section. The tertiaries are about two fifths as long as the principles, and restricted within the zone of cysts, and only occasionally some of them do extend out a little distance. They are comparatively thick, as thick as the thicker end of the principal septa.

Pseudo-columella compressed, sometimes as thin as the thinner end of the septum. One of the principal septa, probably the counter septum, is longer, tapering to the point of junction with the pseudo-columella, but in some sections the opposing one and lateral ones join with it also.

Cysts set loosely in a zone just within the epitheca, with the concave sides inclined to the center in cross-section, like those showing in the *S. yaolingense*. In this case they are easily mistaken for dissepiments which are in the inner portion of this specimen. Their convex sides to the center are often clearly shown in oblique section. Tabulae and dissepiments are in some parts irregularly arranged. They are elevated toward the columella, generally making an angle of about 30° or more with the latter.

Comparison—The present form is very similar to a coral described by a Russian geologist as *Lithostrotion irregulare* Phill. in Memoires du Comité Géologique de Russie, Nouvelle Serie, Livraison 175 (1923) Pl. II, fig. 2, 3, 6. The only difference is that the pseudo-columella of the present form is thinner, and the present form with only a slight difference belongs possibly to the same species, but itself may have been erroneously referred to *L. irregulare* Phill. because it is very different from the typical *L. irregulare* Phill. in (1) more or less variation in size; (2) arrangement of septa which are less regular; (3) difference in outline of cross-section; (4) internal structures which are more complex and irregular than the latter.

This coral is also similar to *L. ramosus* Romanowsky collected from the Upper Carboniferous rock of Kuei Yang Hsien, Hunan, figured by Yabe and Hayasaka in the Paleozoic corals from Japan, Korea and China, Atlas of Fossil Pl. XIII, fig. 2, 2a. But the latter has internal structures more complex, as the tabulae are rather dense, tertiary septa shorter, and principal septa thick and more prominent and larger in size.

Horizon and Locality — Taikuei formation, collected from Taiwan (fossil locality No. 12), Chen Hsien, S. Hunan.

THYSANOPHYLLUM

Thysanophyllum circulecysticum Chu (sp. nov.)

(Pl. III, fig. 1-7.)

Description—Corallum fasciculate, individuals cylindrical, very tall, and the diameter of corallite is about 10 to 12 mm. but much smaller or one-half to one-third of this number in younger specimens. Interspace between corallites is narrow, the corallites sometimes touching one another. Every individual corallite consists of two zones of structure like the trunk of a tree with bark and body part, i.e. zone of cysts-structure with epitheca in the outer and the main part, septa and tabulae. These two zones appear lacking in power of cohering with each other though they are in close contact; because of that whenever we strike the specimen the parts of the outer zone break down and leave the inner part of the corallite

showing the septal grooves and transverse ring-like wrinkles which correspond more or less to the tabulae (fig. 1—3). The thickness of the outer zone is generally about one-third the radius of the corallite, but it is thinner and sometimes only a part of this zone shows in younger specimens. In this we have a thin epitheca showing faint grooves on the outer side, but very clear on the inner side.

Cysts in this coral are different from those in any other species. First, there is only one row, seldom two rows of overlapping cysts. It is very clearly marked in longitudinal section (fig. 6-7). Second, the cysts are ring-like with convex side toward the inner zone; and the shallow part between the lower and the upper cysts, where in contact, correspond to the wrinkles of the outer surface of the inner zone. Because of the ring-like character of the cysts and their slight overlapping they seldom show in cross-section, sometimes only one or two parts being distinct.

In the inner zone—corresponding with the trunk of the tree—there are radial septa, 28 principles (primaries and secondaries) with the same number of rudimentary tertiaries. Principal septa are rather thin and distinctly placed, and extend only half or sometimes perhaps two-thirds the way to the center, with the possible exception of the counter septum, although there is not sufficient evidence to determine it positively, since it is always pronounced by the continuation reaching the center and very often over the center, where the tops of tabulae meet with it. In this case it is easily mistaken for a pali-columella as showing in plate III fig. 4a—4f. This septum as well as other septa are all somewhat irregular, generally bent backward and forward, the thinner toward the ends. Because of this in some sections (fig 4b-4c) the curved part of this septum and the cut top of the tabulae combined have the appearance of a pseudo-columella, and may be mistaken for it by the fact that there is even a little break (fig. 4b). But in other cross sections (fig 4e-4f) the curved part of this septum with the cut top of tabula breaks at a distance and it is also clearly seen in longitudinal sections, so that it can no longer be mistaken for a pseudo-columella. This septum is always present even in the young stage, where the other septa are short or only one-third as long as this and persists throughout. Moreover in the young stage the tabulae are seldom seen but the always pronounced septum is not an exception but is well developed, and the absence of pseudo-columella is naturally revealed.

Tabulae few and loosely set, about two to five millimeters apart, flat in margin but elevated toward the center; and sometimes they are like cone-shaped forms with round flat rims one over the other, but sometimes they are

all flat and gently convex toward the center. The cross section near the calyx (fig 4a) shows the cut top of tabula and no septa projecting attached to it, the septa having been shortened.

Comparison—This coral is similar to *Thysanophyllum successor* (Pl III. fig 2, Mémoires du Comité Geologique de Russie Nouvelle Serie, Livraison 175—1923), but the differences are that in the present form the cyst-structure is more simple, occupies less space and has a very clear epitheca.

This is also similar to *T. longiseptatum* Yabe and Hayasaka (Paleozoic Corals from Japan, Korea and China—by Prof. Yabe & Hay. p. 138, pl. XI. fig. 4a-c) in some respects, but it is different from the latter in that the cyst-structure usually has one layer instead of two, three or more layers; tabulae set loosely and commonly bending upward to the center unlike that of the latter which are usually horizontal and the always pronounced counter septum joining with the top of the tabulae forms the apparent pseudo-columella which is characteristic of the present form only.

Horizon and Locality—Shihertulung formation, Carboniferous, collected from Shih Er Tu Lung (fossil locality No. 4), Chen Hsien, S. Hunan.

HETEROCANINIA

Heterocaninia tholusitabulata Yabe & Hay.

Pl. IV. fig. 1-3.

H. tholusitabulata Yabe & Hay. Paleozoic Corals from Japan, Korea and China, Atlas of Fossil, Pl XIII.

Description—Corallum simple, strongly curved; the growth of the corallite being not uniform but more rapid in width than in height and in one direction more rapid than the other, produces the strongly curved form, and thus the younger part with the adult part makes an angle of about 120°. The cross-section of the younger part being elongated has a diameter of 15 mm. and the longer one a diameter of about 21 mm. A more or less oblique section about 10 mm. above the latter section is oval in form with a diameter of 40 mm. and the shorter one has a diameter of 35 mm. another oblique section which makes an angle with the latter section of about 40° is also oval in outline and has the longer diameter 65 mm. while the shorter has one of about 50 mm.

Epitheca thin. Septa numerous, about 60 in younger section and several times the number in the largest section. These are principal septa in-

cluding primaries, being fully developed in younger part, radial, straight, irregularly but gently bending backward. But in one part the septa are strongly curved near the periphery. All these septa are restricted in the outer zone which is about two thirds of the diameter of the corallite, and never stretch into the central portion which is occupied by a particular form of tabulae and cysts. In cross-section the cut surface of them shows the spider-web arrangement. Since the septa always occupy the outer zone the outline of the central part occupied by the spider-web cysts, is correspondingly more or less elongate or ovate. The cysts always have the convex sides toward the center, and the arrangement of them is generally denser in the outer parts and more scattered toward the center. No tertiary septa, no cysts and dissepiments are present between the septa and no fossula present in the younger specimens, which are well developed in the later part of the corallite. The central spider-web part is generally wanting in the later enlarged section.

In the sections of the later stage of the corallite the cysts and dissepiments are abundant in the outer part near the periphery, but become less towards the center. Tertiary septa are well developed and prominent in the largest section and about $\frac{1}{2}$ to $\frac{1}{3}$ as long as the principal ones. All the septa, both principal and shorter ones, set radially and regularly in the outer part but they become irregular toward the center, one sometimes joining with the others there. They are thickened especially in the younger part, and the whole corallum is filled by stereoplastic deposits. Fossula is in the convex side of the corallite formed by the abortion of one septum which is probably the cardinal septum. It is only one-third as long as the distance from the periphery to the center. The septa on either side of it bend toward it, and some septa embrace the area in which it is situated.

In certain parts of the corallum there is no stereoplastic deposit, where the septum is either present or absent, and thus there are gaps which are filled by the secondary lime fill and can be clearly seen in cross-section by the different colors. These, however, are most probably due to the disease of the animal.

Comparison—The present specimen is slightly different from the specimen (collected from Hsia-Lo-Shi-Chiao, Chiyang-Hsien, Hunan) originally described and figured by Prof. Yabe and Hayasaka in that the growth of the animal being less uniform, there is produced a strongly curved and rapidly enlarged form, and the central spider-web cysto-structure does not persist in the large section as it does in the original specimen of the same size. This is probably the large section of the present specimen representing the older part of it.

Horizon and Locality—Shihertulung formation, Carboniferous, collected from Shih Er Tu Lung (Fossil locality no. 4), Chen-Hsien, S. Hunan.

ACTINOCERAS

Actinoceras (?) sp.

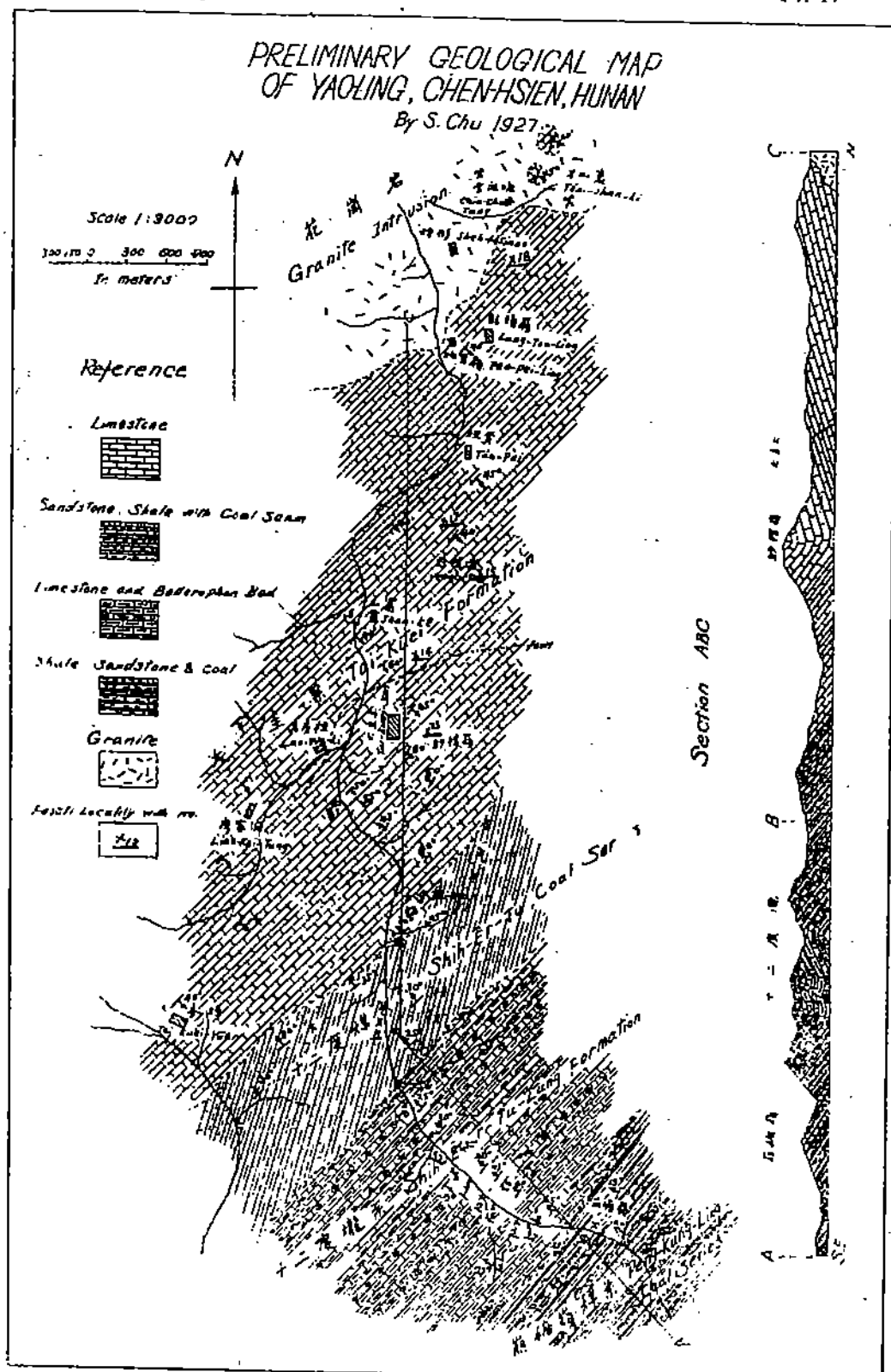
Pl. IV. fig. 4

Description—The specimen is a natural longitudinal section but only an oblique section of the lower part of it passes through the siphuncle, and thus we have the clear nummuli. Shell slender with a tapering rate at 1 in 6. The length of the specimen is about 14 cm., the lower part of the shell being broken away. If we take the tapering rate to be uniform for the whole shell and assume the diameter of the protoconch shell to have been 2 or 3 mm. the broken part must be 8 centimeters or more.

The cross-section of the shell is probably sub-oval. Camerae fairly uniform, their length being almost always 5 mm. in the lower part, but that in the upper part being more or less irregular and from 6 to 7 mm. The Concavity of them is about two-thirds of a nummula in the lower part while that in the upper part is less and even flat. Septa are well shown in the lower part of the shell but incomplete in the upper part. Stereoplasmatic thickening of the septa is restricted to the upper side only. This is also pronounced in the lower part and thicker towards the outer wall of the left hand side; an irregular filling occupies the right hand side of the siphuncle, and it has a width of about one-third of the diameter of the shell throughout, but is irregular in the upper part.

Siphuncle sub-marginal, and showing in the lower part of shell only, for the specimen is an oblique longitudinal section. The nummula has a curious form, which is different from that of any other *Actinoceras* and leads me to have doubts as to the wisdom of considering the present form as an *Actinoceras*. It is just like the head of an eagle without feathers and skin, i. e. one end is round and the other is similar to the open beak of an eagle, and these nummuli are situated on the shallow part of the septa where the stereoplasmatic deposit is thin.

Horizon and Locality—Shihertulung formation, Carboniferous, collected from Shih Er Tu Lung, (fossil locality no. 5), Chen Hsien, S. Hunan.



**EXPLANATION OF
PLATE II**

PLATE II

Siphonodendron yaolingense Chü (sp. nov.)

- Fig. 1a Cross sections. $\times 4$
1b Longitudinal section. $\times 4$

From Taikuei Formation, Yao Ling, Chen Hsien, S. Hunan.
(Loc. 15)

Siphonodendron yaolingense Chü

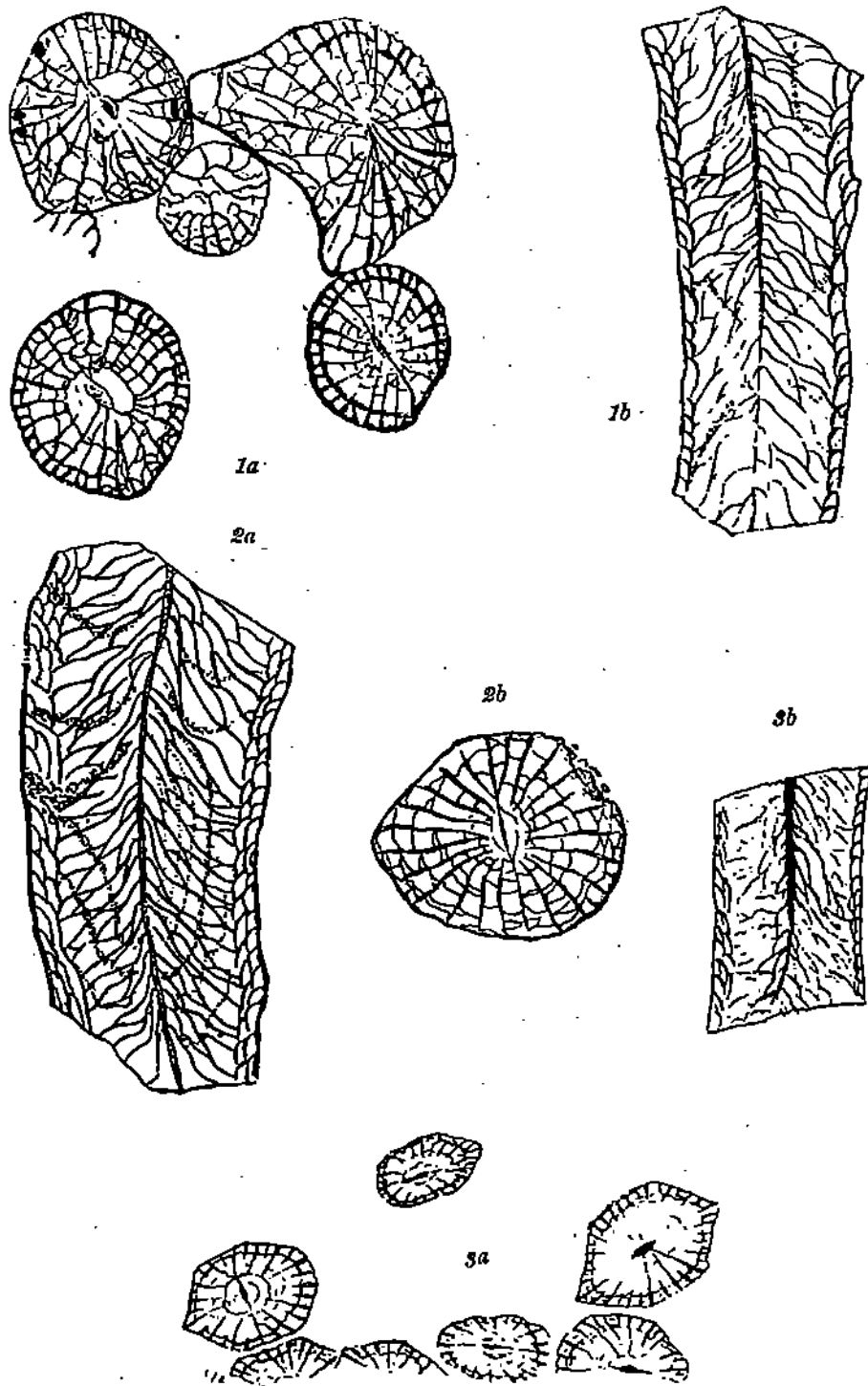
- Fig. 2a Cross-section $\times 4$.
2b Longitudinal section. $\times 4$.

From Shihertulung Formation, Yao Ling, Chen Hsien, S.
Hunan. (Loc. 3)

Siphonodendron hunanese Chü (sp. nov.)

- Fig. 3a Cross-sections. $\times 5$.
3b Longitudinal section. $\times 5$.

From Taikuei Formation, Yao Ling, Chen Hsien, S. Hunan.
(Loc. 5.)

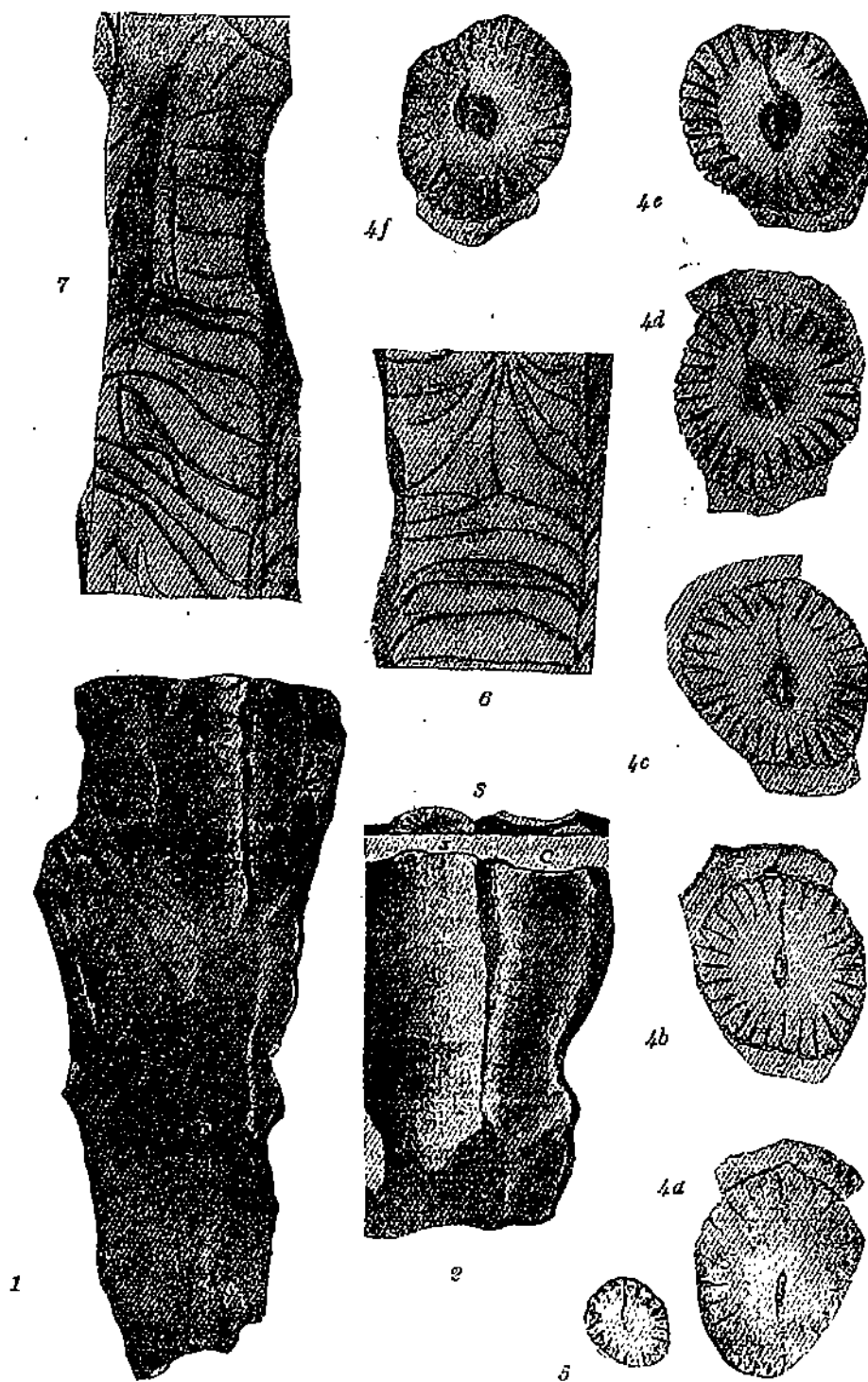


**EXPLANATION OF
PLATE III**

PLATE III.

Thysanophyllum circulocysticum Chü (sp. nov.)

- Fig. 1. Side view; natural size.
2. Side view; a part enlarged $\times 2$, showing the cysto-zone (c) removed from body portion (S) of corallum.
3. Top view showing the relief of body portion and concavity of cysto-zone. $\times 2$.
- 4a-4f. A series of cross-sections of one individual corallite, $\times 3$.
- 4a. Uppermost section near the calyx
- 4b. Section 2 mm. below 4a.
- 4c. Section 3 mm. below 4b.
- 4d. Section $\frac{1}{2}$ mm. below 4c, reversed.
- 4e. Section $1\frac{1}{2}$ mm. below 4d.
- 4f. Section $\frac{1}{2}$ mm. below 4e, reversed.
5. A section of the early part of another corallite showing the pronounced counter septum and a part of cysto-zone developed in the younger part. $\times 3$.
- 6—7 Longitudinal sections, $\times 3$.
- From Shihertulung Formation, Yao Ling, Chen-Hsien, S. Hunan.



**EXPLANATION OF
PLATE IV**

PLATE IV

Figs. 1-3. *Heterocaninia tholusitubulata* Yabe & Hayasaka, Natural Size.

1. A Cross-section of younger part, showing two distinct zones, spider-web cystose zone and the outer zone occupied by principal septa without outer zone of cysts and dissepiments; but there is a tendency of formation of fossula (f) wherein cardinal septum is situated. Section reversed.
2. An oblique section 10 mm above section 1, showing the outer zone of cysto-dissepiments, or cysts between the septa. Septa extend to the spider-web cysto-zone.
3. A polished section and a rather diagrammatic section of the same showing clearly the arrangement of septa and the counter quadrants accelerated. C = cardinal septum; A = alar septa.

From Shihertulung Formation, Yao Ling, Chen Hsien, S. Hunan.
(Loc. 4).

Fig 4. *Actinoceras* (?) sp.

A polished longitudinal section, natural size.

From Shihertulung Formation, Yao Ling, Chen Hsien, S. Hunan.
(Loc. 5)

