

CORALS OF THE UPPER SILURIAN SPIRIFER
TINGI BEDS OF KWEICHOW.

BY A. W. GRABAU

The corals described in the following pages were obtained from the limestone with *Spirifer tingi*, by V. K. Ting in 1929 in Kweichow, west of Machiatun, Kweitung district. Loc. T107 and T107a.

Genus FAVOSITES Lam

1. FAVOSITES FORBESI Edw. and Haime var KWEITUNGENSIS

Grabau (var nov.)

Pl. I, Figs. 1-3 Pl. II, Figs. 4-5 (Nos. 1-6, slides 7-10, Nos. 11-13, slides 14-18)
cf 1902 *Favosites forbesi* var *nitidula* Barrande, Pocta in Barrande Système
Silurien de la Bohème, Vol. III Pt. 2, p. 240, Plates 77, 83, 91, 92.

Subglobular masses, mostly between 7 and 10 centimetres in diameter, but smaller forms also occur. Corallites relatively smooth-walled, the rugosities due to the growth-lines being slight. Mural pores very fine, apparently in several rows, but none of our specimens are sufficiently well preserved to show them clearly on the exterior, corallites of two sizes, the larger pentagonal or hexagonal, the smaller scattered among them, pentagonal or quadrangular. The following details are exhibited by the sections.

Section 8 (Pl. I, Fig. 1) A transverse section of a small head about 22 mm in diameter. The larger corallites with a diameter of 1.3-1.4 mm, the smaller 0.7 to 0.5 mm mostly quadrangular, while the large corallites are generally hexagonal though occasionally pentagonal. The combined wall of the adjoining corallites 0.2 mm in thickness.

Section 17. (Pl. I, Fig. 2) The larger corallites, are usually hexagonal, 1.7-1.8 in maximum diameter, but among them are others 1.6 mm in diameter and still other pentagonal ones one millimetre in diameter. These are usually found at the junction of 4 larger ones. The smaller quadrangular corallites are about 0.8 millimetres in diameter, while still smaller triangular ones are occasionally seen. There is a rather indistinct rosette-like arrangement of the corallites, one of the larger 0.8 mm in maximum diameter being surrounded by a ring of slightly smaller ones, ranging from 0.4 to 0.6 mm in diameter.

Section 15 (Pl. I, Fig. 3) This is a very satisfactory longitudinal section of a fragment, showing the principal corallites and the smaller ones arising

between them. The maximum width of the corallites in the section is 0.7 mm. The walls are very thin, occupying scarcely more than 0.1 mm between the adjoining corallites. The tabulæ are of the same thickness as the double walls of the corallites and from 0.7 to 0.8 mm in maximum distance apart in the lower part of the section, whereas in the upper part they are more crowded, being 0.5 mm. and sometimes only 0.3 mm apart. A number of measurements will serve to give the range.

In intervals of 3 mm, the corallites show.

Corallites 1.		Upper end	Lower end
		7 in 3 mm	7 in 3 mm
"	2.	8 " " "	7 " " "
"	3.	7 " " "	6 " " "
"	4.	7 " " "	6 " " "
"	5.	6 " " "	5 " " "
"	6.	6 " " "	5.5 " " "
"	7.	6.5 " " "	7 " " "

The tabulæ are essentially horizontal, only in rare cases is there a faint downward bowing and more rarely, in the upper part, a slight convexity upwards. Indications of mural pores are rarely seen, though occasionally we can recognize a row of pores near the lateral margin of the section, one of which lies midway between each 2 tabulæ. In other sections, the pores are seen to occupy the center of the section and sometimes we find them arranged in 3 adjoining chambers one in the center of the middle chamber and one on each side of the two flanking chambers, making 5 in all arranged like the 5 spot on a dice.

Section 18 (Pl. II, Fig. 4) In this section 2 fragments are shown, the one shows a nearly perfect longitudinal section, there being slight variation in the breadth of the corallite section, apparently due to a flexuous character of the corallite. In a corallite with essentially parallel sides the breadth of the corallite section is 1.5 mm, while the broadest part of a flexuous tube shows a diameter of 1.7. In the upper part of the fragment i. e. the part which probably represents the surface of the corallum, the tabulæ are very crowded, 5 of them occupying the space of 0.7 mm that is, the space which in the lower part often only includes 2 adjoining tabulæ. Taking a few measurements as in the preceding section, we have the following.

No. of tabulæ in 3 mm.	Lower part	Upper part
Corallite 1.	6 in 3 mm.	9 in 3 mm.
2.	6 " " "	11 " " "
3.	7 " " "	10 " " "
4.	6 " " "	11 " " "
5.	6 " " "	10 " " "

From this it will be seen that there is a pronounced crowding of tabulæ in the upper part. This portion with extremely crowded tabulæ occupies only about 1 mm. of the surface, but there is also more or less crowding in the upper 4 mm. The total height of the fragment is 14 mm.

Another fragment sectioned in the same slide shows only a few of the corallites cut longitudinally. The majority are cut obliquely, while in the very basal portion, cross sections of the corallites are shown. Those of the larger tubes have a diameter of 1.7 while the smallest one is 0.4 mm. in diameter. This section too shows the crowding of the tabulæ at the summit, there being from 5 to 6 of these in the space of 1 mm.

Section 9 (Pl. II, Fig. 5). This is our largest section, measuring from the center to the periphery 56 mm. In the central portion, it forms one side of our section, the corallites are sectioned at right angles and the largest, which is pentagonal has a diameter of 1.8 mm, while the slightly smaller tubes surrounding it, range from 1.3 to 1.5 mm. in diameter. The smallest tubes intercalated between the larger ones and mostly of quadrangular outline, have a diameter of 0.7 mm. or less.

The outer part of the section, for a distance of as much as 30 mm. in some parts, shows continuous tubes, with the sides often parallel for a considerable distance, showing very little flexuosity in the tubes, which in their widest part show a width of 1.7, but more usually only 1.5 mm. Measuring the tabulæ as before in the upper and lower portion, which is here more distant than in the other sections, (maximum distance 30 mm) we have the following number of tabulæ in 3 mm.

Corallites	Lower part	Upper part
1.	7 in 3 mm.	6 in 3 mm.
2.	8 " " "	8 " " "
3.	7 " " "	8 " " "
4.	6½ " " "	8 " " "

In this corallum, there is a zone a short distance from the base where the tabulæ are crowded, from 9 to 10 occurring in the space of 3 mm, but both above and below they are more distant, the number being from 6 to 7. Again near the surface the crowding is such as to average about 10 or 11 in 3 mm. The extreme crowding shown in some of the other sections is not seen here, as the specimen is probably incomplete at the surface. Pores are rarely shown in this section but now and then there is an indication that they were distributed in 3 rows, in quincunx fashion, every alternate chamber having one median, while the flanking ones have one on each side. This however is not uniform.

We may then summarize the characters derived from the sections as follows. Diameters of the larger corallites generally 1.7 mm, though ranging to 1.8 mm on the one hand and 1.6 or even 1.5 on the other. These larger tubes are either hexagonal or pentagonal, often it can be seen that a tube of maximum diameter is surrounded by a rosette of slightly smaller ones and outside of this are the intercalated smaller tubes which are generally quadrangular in section. These smaller tubes range from 0.5 to 0.7 mm in diameter, though sometimes falling below the minimum. The walls are thin, the combined walls of adjoining corallites generally having a thickness of 0.1 mm, though sometimes in cross-section showing a thickness of 0.2 mm. The tubes are mostly straight or very slightly flexuous and the tabulæ are horizontal rarely gently curved, from 6 to 7 in the space of 3 mm, but crowded at the surface, so that 5 or more may occur within the space of 1 mm. There are also occasional zones, in which the crowding is slightly greater, from 10 to 11 occurring within the space of 3 mm. The mural pores are small, apparently arranged in 3 rows, alternating, 1 median, with 2 lateral pores in successive chambers. There are no septal spines or trabeculæ.

Comparison: In typical *Favosites forbesi* there is always an arrangement of large pores, often 4 to 4.6 mm in diameter and of octagonal outline, surrounded by smaller ones more or less pentagonal in outline and from 1 to 2 mm in diameter, while the tabulæ average about 12 to 13 in 3 mm. Ordinarily the typical form, as it occurs in the Bohemian basin, is more or less disk-shaped, but var *nitidula* Barrande from the Silurian 2, is top-shaped (Pocta Pl. 83) or subhemispherical (Pocta Pl. 91 and 92) and shows an arrangement of corallites, essentially as in our variety with the larger pores hexagonal and the smaller ones pentagonal or quadrangular. In this the larger corallites

have a diameter of from 1 to 1.8 mm while the smaller have a diameter of from 0.4 to 0.8 mm. The tabulæ however are more variable than in our variety, there being usually from 8 to 10 in 10 mm, but near the aperture they are also much crowded, there being according to Pocta as many as 9 in 0.5 mm which crowding is much more remarkable than in our variety.

HORIZON AND LOCALITY:—In the Upper Silurian *Spirifer tingi* Beds of Loc. T107 West of Machiatun Kweitung in Kweichow. Collected V. K. Ting. Several specimens.

Genus *OMPHYMA* Rafinesque & Clifford

2. *OMPHYMA GLOMERATA* Grabau (sp. nov.)

Pl. II, Figs. 6-8

(Nos. 24-27, 38, Slides 28-30)

Corallum a-glomerate mass of corallites, budding from the calyx of the older corallum and apparently extending in all directions, so as to result in the formation of a subspherical mass reaching a diameter of 7 centimetres or more. The larger corallites may reach a diameter of 3 cm or over, the corallites budding from them seldom exceeding $\frac{1}{4}$ or $\frac{2}{3}$ this size.

The calyx of the smaller corallites is of moderate depth reaching 30 mm where the diameter is 21 mm. The calyx margins are sharp and the septal ridges very low and often scarcely discernable. In some of the corallites of specimen 25, however, they are low, broad, convex ridges 3 of which, at the calyx rim, occupy a space of 2.5 mm. In another corallite of the same group, where the calyx rim is broken, these septa are seen as ridges somewhat sharper in the center, but still of the same width and very slightly projecting into the calyx. None of our specimens show external interseptal ridges, and they are only faintly indicated in the cross-sections.

Cross-Section (Pl. II, Fig. 6): Section No 30, of a large corallum with several smaller ones on its interior, shows the following characters. The diameter of the section is 27.5 mm, and the wall formed by the septal layers has a thickness of 1.4 to 1.1 mm. On the exterior this is marked by a dark epithecal layer which is relatively smooth, showing no septal ridges, though at least one short proliferation is seen, projecting abruptly for a distance of 0.5 mm with the same basal diameter, while the incremental lines curve into it. This is seen at the thickest point of the wall. On the interior side of the wall, the sections of the broad round septal ridges are well shown, their basal width

reaching in some cases 1 mm, or 3 in 3 mm while in other cases 3 occupy only 2.5 mm. On the side, where the 3 buds are given off in the calyx, the wall of the latter is covered by broad shallow cysts, these ranging in length up to 7.5 mm in the longest, with a depth in the same of 1.5 mm. The cysts themselves are thin-walled and they cover the septal ridges. In most cases, there are no indications of septal ridges on the cyst walls themselves, but on the calycinal surface of the largest and the one next adjoining small septal ridges are shown these being only half the size of the main septal ridges. Apparently these cysts are confined entirely to the side where the small corallites bud off, which may be due to a slight obliquity in the section, the cyst-free portion representing the upper part of the calyx wall.

The 3 individuals which have budded off from the interior are closely attached to the cysts of the inner wall on one side, there being no independent wall on this side, but they are free on the other and separated from one another. The best preserved has a diameter in the radius of the main axis of calyx of 8 mm, but the transverse diameter of this same individual is only 7.2 mm, the section being thus slightly oval. The others are of the same size, but they are more or less crushed. The wall of the well-preserved individual has a thickness of 0.8 mm, that of the others is thinner, in the next individual it is only 0.4, while in the 3rd individual, it is 0.5 mm. This represents of course different levels at which the individuals are cut. Very low interseptal ridges are shown on the exterior of these small corallites, 3 of them occupying a space of about 1.4 mm. This is also the interval covering 3 of the low septal ridges on the interior, these being more pronounced in the individuals with the thicker than in those with the thinner wall. There is a suggestion of the presence of cysts even in the smaller individuals, but they are not so definitely determinable, because of the irregular tabulæ, sections of which also appear in the cross-section.

Longitudinal Section (Pl. II, Fig. 7): Slide 29 is a vertical section of 3 adjoining individuals, but one is only represented by a fragment. All 3 individuals however, are in contact in their upper portion, separated only by a very thin and somewhat irregular dark line which represents the epitheca and which shows thickening on either side, by the septal layers. In the two complete individuals, the double wall thus produced has a thickness of 1 mm. Within this wall is a group of oblique and rather coarse cysts, the larger of which reach a length of from 4 to 6 mm and a depth of about 1 mm. In one of

the individuals, where the bottom of the calyx shows a diameter of 6.4 mm, the entire thickness of the wall formed by cysts is 3.2 mm on one side and even more on the other. The calyx as such is almost beaker shaped, with the floor nearly horizontal and formed by cysto-tabulæ. In the central individual, where the section seems more nearly along the vertical axis, these tabulæ are sometimes complete and separated from the cysto-zone by a strong vertical wall, formed of the thickened and combined edges of the cysts. Where the diameter of the tabulate zone is 9.2 mm, that of the cystose zone on one side is 2.0 mm, and on the other, where it is somewhat irregular, from 1.4 to 2 mm. On this side, the thickened inner wall, which divides the cystose and tabulate areas, has a thickness of 0.6 mm, but the corresponding wall on the opposite side is only about half as thick. The maximum interval between two sub-parallel tabulæ which extend entirely across the tabulate zone is 0.7 mm, but where the tabulæ are more irregular and of a cystiform character, the interval may be 1 mm. or more. In this same individual the cysts in the calyx wall may reach a depth of 2 mm. and a length of 4.6 mm, but in general, when regular, they are less than half this size. The maximum diameters of the two corallites in this section are 14.3 mm. and 13.8 mm. respectively.

Section 23. (Pl. II, Fig. 8): This shows 4 adjoining corallites but only 3 of these approach completeness and in only one is the section approximately a median longitudinal section, so as to show the calyx. This shows that the axes of the various corallites lie in different positions. As in the other case, the corallites, where in conjunction, are separated only by the dark wavy epithecal line, on either side of which there is a stereoplasmic thickening, i. e. septal layers, and within this a cystose zone, while the center is occupied by the tabular zone. The individual which shows the most perfect section has a length of 17 mm, 5 of which is occupied by the beaker-shaped calyx. The basal part of the section however is not shown. The diameter of this individual in the upper part is 17.3 mm, while that of the base of the calyx is 7.4 mm, and the top 9 mm. The cystose wall of the calyx on one side, has a thickness of 4. mm, on the other of approximately 6. mm. 7.5 mm below the floor of the calyx, the diameter of the tabulate zone is still 7.2 mm, which is very slightly less than that of the floor of the calyx. Several of the tabulæ are seen to extend clear across the tabulate zone but the majority are somewhat cystiform, not reaching entirely across the zone. In the adjoining individual however, the median of the 3 most complete corallites, many of the tabulæ extend entirely across the tabulate zone, which here has a diameter

of 7.5 mm. The tabulæ however are not always perfectly horizontal and some of them are cystiform, while the intertabular space ranges from 0.5 to 1 mm. In the upper part of this individual the section cuts obliquely across the epitheca, which is here seen to be distinctly marked by the wavy lines which indicate external interseptal ridges.

No indications of epithecal proliferations have been seen in any of these small individuals either in longitudinal or transverse sections.

I know at present of no species of this genus with which these specimens may be compared, for the normal forms as they occur in the Silurian rocks of western Europe are single individuals. In the character of the marginal cysts and the central tabulæ however, our individuals may be compared with typical European forms, though as a rule both cysts and intertabular spaces are larger and the septa less prominent.

HORIZON AND LOCALITY: In the Upper Silurian *Spirifer tingi* beds of Loc. T107, west of Machiatun, Kweitung district in Kweichow. Collected V.K. Ting, Specimens 24-27, Slides 28-30.

3 OMPHYMA CYSTIPHYLLOIDES Grabau (sp. nov.)

Pl. III, Figs. 9-12

(Nos. 19ab, 20, Slides 19, 21-23)

Several individuals of a broadly conical character and simple habitat presents such differences in form and internal structure, that they must be referred to a distinct species. Unfortunately they are all so deeply embedded in rock, that the characteristics can only be made out from the slides. Nevertheless, what appears to be the epithecal surface of one of these is exposed in specimen 20 in the upper third of the corallum and there it shows what appear to be distinct bases of hollow epithecal proliferations. The specimens all appear to be incomplete, the basal portion usually being decorticated. The detailed structure can at present only be determined from the sections, though in one case, there is shown in specimen 19, what appears to be a part of the calicular wall of an individual showing broad septal ridges of a low convex form and alternating in size. The larger have a width of 0.9 mm and the smaller of 0.5 mm, the space which includes 2 of the larger and one of the smaller thus measuring 2.3 mm.

SECTIONS

Section 21. (Pl. III, Fig. 9): This is a longitudinal section of the individual represented by specimen No. 19. It is perhaps the most

nearly median section that we have. The section is incomplete, part of the corallum being missing, but as nearly as can be estimated, the calicinal diameter was about 23 mm, while the basal diameter of the fragment is 10 mm, below which point the individual is broken away. The calyx is rather flaring and broadly funnel-shaped, the depth being 11.5 mm, whereas the total length of the fragment is 23.5 mm, the original total length of the corallum being in the neighbourhood of 30 mm. It is not certain that any part of the epitheca is shown though in the lower part, where it seems to be preserved, there is a very short, almost spinose proliferation, which appears to have been one of the radiform extensions. The wall here is thickened by stereoplasm, probably septal layers, measuring 0.7 mm in thickness. Above this the structure appears to be in the form of somewhat flaring funnels of stereoplastic material, sometimes 1 mm in thickness, but usually somewhat less. In slide 21, the first of these is in contact with the wall described as bearing a proliferation, but this is only for a short distance, and farther up it becomes separated, and between it and the outer wall a development of small outer cysts is seen. Of this however, only a very small part is preserved, the greater part, together with the outer wall and epitheca being destroyed in the specimen. Evidently the surface of this layer at one time formed the calyx of this wall and further down, beyond the point where it is in contact with the older wall, it is seen to extend across the corallum as an incomplete tabula, while in the portion of the corallum, which it thus cuts off below it, there are a number of coarse cysts. Upon the surface of this thickened floor of the early calyx, a series of large cysts were formed as well as few nearly complete tabulae, these latter being separated by intervals of 1.3 mm. The side walls of the old calyx are covered with cysts, but not to the same extent as the floor of the calyx, which is built up by cysts and tabulae. The next higher funnel layer, part of which forms the last calyx floor, was in part at least separated from the older portion by a hollow space now filled with the dark brown lime mud, in which the entire fragment is embedded, or possibly some of the coarse cysts were filled with this lime mud on fossilization, though all the other cyst cavities are filled with crystalline lime. In the bottom of this higher funnel layer, a few coarse cysts occur, forming the base of the broadly funnel-shaped calyx.

Section 23. (Pl. III, Fig. 10): This is a partial section of the same corallum as the preceding, and it shows the surface of the corallum partly destroyed, so that there is nothing of the epithecal wall visible. Parts of the coarser

funnel-like layers are preserved but most of the section shows only coarse and very irregular cysts.

Slide No. 23. (Pl. III, Fig. 11): This is a longitudinal section of the somewhat smaller specimen No. 20. This has a preserved length of about 19 mm, with an original length approaching 25 mm. and a calicinal diameter, as nearly as can be judged, of 20 mm. and a diameter in the lower part of 10 mm. The calyx has a preserved depth of 7 mm, but may have been as much as 9 mm. or more in the first place.

This individual shows the invaginated funnel form much more strikingly than is seen in the other specimen, some 8 of these funnels still being recognizable. In some parts, the successive funnels are in close contact, in others there is an interval of 1 or 2 rows of rather large cysts, though these rarely separate the funnels throughout. Most of them are in contact in the lower part of the corallum, but become separated by cysts in the flaring calicinal portion. In the center of the corallum, the funnels are usually flattened so as to form transverse tabulæ, this tabular space ranging in diameter from 3 to 4.5 mm. Three of these tabulæ, with their interspaces, occupy a space of 4 mm. in the lower preserved part of the corallum. There were apparently low septal ridges on the surfaces of the funnels, if we may judge by the appearance in the section, but this requires confirmation and better material.

Section 19. (Pl. III, Fig. 12): This is a partial cross-section through the calyx and shows a part of the calicular wall. The diameter of the corallum at this point is approximately 25 mm and that of the calyx 16. The thickest part of the calicular wall is 6 mm, but the external part is incomplete. There are 3 thick layers, but they are not continuous. The two exterior reunite and the inner one breaks up locally into cystose structure. The thickness of the single layers is usually less than 1 mm but more where two have combined into one. The interspaces between these heavier layers show cysts of moderate size, the longest being nearly 6 mm in length and 1.3 mm in depth, but the majority are much smaller. No septal ridges are recognizable in this section.

HORIZON AND LOCALITY: In the *Spirifer tingi* beds of Upper Silurian age, Loc. T. 107, west of Machiatun, Kweitung District, Kweichow. Collected V. K. Ting. Associated in the same fragment with *Favosites forbesi* var. *kweitungensis* Gr. and *Spirifer tingi* Grabau.

Genus CYSTIPHYLLUM Lonsdale

CYSTIPHYLLUM OMPHYMIFORME Grabau (sp. nov.)

Pl. III, Figs. 13-15

(Nos. 37, 52, 53, 55, Slides 48-51, 54)

This species is represented by a number of short rather irregular cylindrical coralla of slight diameters, of which specimens 52, 53 and 55 and slides 48, 50 and 54 represent portions of the holotype.

The corallum has an irregular exterior and is apparently entirely without longitudinal ridges. The calyx is of moderate depth, with the floor formed entirely of cysts and there is only very faint indication of septal ridges, these being very narrow and scarcely discernible.

Sections: A longitudinal section of the holotype (section 54 Pl. III, Fig. 13) has a length of 13.5 mm and its diameter at the upper part is 15.5 mm and at the lower part 16.3 mm, but half way between these two points, it contracts to 13 mm, or even less. This is apparently due to the decorticated character of the exterior, so that the outer margin is extremely rough, with projecting funnel edges and the margins of open cysts. The structure is of the nature of a series of shallow cups formed by thickened layers of stereoplasm. These extend across the entire corallum and are only slightly invaginated, the spaces between being filled with coarse cysts. The margins of these cups project on the sides of the decorticated corallum. A single cup has a depth of 8.4 mm and a diameter, at the rim, of 14.7 mm, while the gently concave bottom has a diameter of 8.4 mm. The thickest part of the layer forming this cup, is 1.3 mm and the maximum distance between it and the bottom of the next succeeding cup is 3.7 mm. The next higher cup has a bottom thickness of 1.8 mm. The successive layers of which the cups are composed are not always continuous but in contact at one point and separate at another to form cysts. Some of the cysts are large, equalling the width of the basal part of the cup, others are small, but all are convex upwards. This structure is an accentuation of that found in *Omphyma glomerata* and even more so of that in *Omphyma cystiphylloides* but the cups are less frequent and the cystose structure between them is more pronounced.

Section 50 (Pl. III, Fig. 14): This section, which has a maximum diameter of 12.5 mm, is apparently just below the calyx and shows a few small marginal cysts, some of them now and then bearing a suggestion of septal

ridges, but these are so indefinite that their presence cannot be positively asserted. The central area shows the irregular sections of a few of the coarser cysts.

Section 48 (Pl. III, Fig. 15): This section, with a maximum diameter of 12.7 mm, is at the base of the fragment referred to, and shows essentially the same characters as in the preceding section. The marginal cysts are shallow, and while there are occasional minute projections, there is no positive indication of septal ridges. The central area shows sections of the coarser layers which form the tabuloid cups and others of the cystose tissue. On the inner surface of the former, there are seen in a few places, regularly spaced projections which might suggest septal ridges, but these appear only in limited areas.

Two other sections of specimen 37 (Nos. 51 and 49) are apparently of the same species, but taken from a different fragment.

Section 49. This has a maximum diameter of 8.3 mm and shows a series of moderately coarse marginal cysts, some of which are filled with the matrix, showing that they were open on fossilization. The section cuts apparently between two coarse cyst surfaces.

Section 51. This has a maximum diameter of 10 mm. and shows only coarse cysts, with the central area, which possibly represents the calyx, filled with the brown matrix.

COMPARISON: This species has the cylindrical character, rough exterior and coarse cysts of *Cystiphyllum placidum* var *approximans* Barrande, from the Silurian (division E) of Bohemia (Pocta, in Barrande, Vol. VIII Pl. 42, Figs. 9-14) but that coral does not show the same striking thickened layers in the successive cups, nor the marked cystose structure. Nevertheless the two are very close. The Bohemian species shows a few longitudinal external ridges in places. The diameter is also about half again as large as in our specimens. In many respects our coral approximates more closely in structure to *Omphyma* than it does to *Cystiphyllum* but it lacks the characteristic septal ridges.

HORIZON AND LOCALITY: In the *Spirifer tingsi* beds of Upper Silurian age at Loc. T107, west of Machiatun Kweitung, Kweichow Province. V. K. Ting collector.

5 *CYSTIPHYLLUM* sp.*Specimen 42 a, b, Slide 42.*

A small specimen represents apparently a distinct form of *Cystiphyllum*, judging by the longitudinal section, which shows the entire interior filled with cystose structure, without any stronger cup-like layers, as in the preceding species. The exterior is not fully preserved, and the form of the corallum has not been definitely ascertained. The length of the section is 12 mm. and the maximum diameter 9.5 mm.

HORIZON AND LOCALITY: In the *Spirifer tingi* beds of the Upper Silurian at Loc. T. 107, west of Machiatun Kweitung, Kweichow, Collector V. K. Ting.

Genus AMPLEXUS Sowerby

6 AMPLEXUS cf. LOJOPINGENSIS Grabau.

Pl. III, Figs. 17-19

(Nos. 34, 35a-b, Slides 35, 36 and 44)

1928. *Amplexus lojopingensis* Grabau. Palaeozoic corals of China Pt. II Palaeontologia Sinica, Series B, Vol. II, Fasc. 2, page 143, Pl. V, figs. 8-13.

A small coral of an amplexoid character apparently represent this Lower Silurian species, but there is not enough to indicate whether it possesses all the characters of that species, since the present individual has not passed beyond the primitive conical stage. The original specimen had a length of about 22 mm and a maximum diameter at the calicinal rim of 17.0 mm while the transverse diameters which is somewhat less, though the corallum does not seem to be compressed, is 4.5 mm. The calyx has a depth of at least 11 or 12 mm, possibly more. Externally the interseptal ridges and septal grooves are well developed, the latter rather deep, the former broadly rounded. Three of them, at the calyx rim, occupy a space of 2.4 mm.

SECTIONS

Section 36. (Pl. III, Fig. 17): This is a transverse section through the calyx, and has a maximum diameter of 11.5 mm while the thickness of calyx wall is 0.7 mm. The center of the calyx is filled with the brown mud, in which there is embedded a small gastropod (*Holopea* cf. *yilungensis*). The interseptal ridges and grooves are strongly developed, the latter on the interior being continued in the incipient septa. Three of the interseptal ridges occupy the space of 2 mm, this being the distance covering 4 septa, measuring from the center of the first to the center of the 4th.

The second section No. 44, (Pl. III, Fig. 18) may be of this same individual, but this is not absolutely certain, since the maker of the section did not exercise sufficient care to keep the sections together. The section is incomplete on one side, with a maximum diameter of about 10.5 mm, while the transverse diameter is 7.8 mm. The section is below the calyx and shows septa 1.4 mm in length. The interval covering 4 septa measured from tip to tip of the outer ones, is 1.6 mm on the inner end, while the same interval on the exterior is 1.8 mm which is also the interval covering the corresponding interseptal ridges. The septa themselves occupy 0.3 mm or less at their thickest portion, while the interseptal spaces are somewhat wider. The center area is filled with crystalline calcite indicating that the section is made between tabulæ.

Longitudinal section. Section 35 (Pl. III, Fig. 19) is a longitudinal section of a part of the same material from which the transverse section no. 36 was made (specimen 35 a,b). The maximum length of the section is 14.0 mm and its maximum width 13.0 mm. A part of the matrix-filled calyx is shown in the upper portion and below this five tabulæ are shown with the following distances between them from the top downward:

1-2: 1.5 mm inner edge;	2.7 mm outer edge
2-3: 1.5 mm " "	2.2 mm " "
3-4: 1.3 mm " "	1.7 mm " "
4-5: 1.3 mm " "	2.4 mm " "
5 to tip: 1.5 mm " "	1.7 mm " "

The tabulæ are nearly flat in the center but slightly bent down on the sides. The second tabula bends down abruptly on the outside and is extended into what appears like a root-like extension, but is probably a part of the original corallum the outside of which was broken on embedding in the matrix. The end of the down-bent portion of the second tabula is 4.4 mm distant from the corresponding end of the uppermost or first one. Except at this one point there is no irregularity and there is no cystose structure.

HORIZON AND LOCALITY: In the Upper Silurian *Spirifer tingi* beds of Loc. T107a (pavement) W. of Machiatun, Kweitung district, Kweichow province. V. K. Ting Collector.

COMPARISON: So far as the general form, rate of tapering and external marking by septal grooves is concerned this specimen agrees well with the young from the Lojoping series (Lower Silurian) of the Sintan region in Hupeh

(vide loc. cit. pl. V, fig. 9). The septa too are similar (vide fig. 12a) but the tabulae are more distant than in the Lojoping coral where from 15 to 18 tabulae occur in 1 cm whereas in the present form the number in the same interval would only be about 9. As this is the apical portion of a corallum—i.e. the diverging part, whereas the section measured in the Lojoping coral is in the cylindrical part, the comparison is not quite valid, for the apical portion of that corallum may have its tabulae at less frequent intervals than in the cylindrical part. More material is needed to make complete comparison.

RECORD OF SPECIMENS AND SLIDES

Silurian Serial No.	Cat. No. Geol. Surv. China.		Pl.	Fig. x 2
1-6	3000	<i>Favosites forbesi</i> E. & H. var <i>kweitungensis</i> Grabau 6 fragments.	-	-
7	3001	ibid. slide longitudinal and oblique section.	-	-
8	3002	ibid. slide transverse and longitudinal section.	I	I
9	3003	ibid. slide longitudinal and diagonal	II	5
10	3004	ibid. section partly transverse partly long.	-	-
11-13	3005	<i>F. forbesi</i> var <i>kweitungensis</i> 3 fragments	-	-
14	3006	ibid. slide section more or less oblique.	I	3
15	3007	ibid. slide longitudinal section	-	-
16	3008	" " oblique section	-	-
17	3009	" " cross section	I	2
18	3010	" " longitudinal section	II	4
19	3011	<i>Omphyma cystiophylloides</i> Grabau cross section of 19a-b	III	12
19a-b	3012	" " 2 fragments	-	-
20	3013	" " another specimen	-	-
21	3014	ibid. long. section of 19 a-b with <i>Favosites forbesi</i> var. <i>kweitungensis</i> .	III	9
22	4015	" another longitudinal section of spec. 20.	III	11
23	3016	" longitudinal section of 19 a-b at right angle to 19.	III	10
24-27	3017	<i>Omphyma glomerata</i> Gr. 4 fragments.	-	-
28	3018	Ibid. longitudinal section	II	8

RECORD OF SPECIMENS AND SLIDES (Continued)

Silurian Serial No.	Cat. No. Geol. Surv. China.		Pl.	Fig. x 2
29	3019	Ibid. another longitudinal section	II	7
30	3020	„ transverse section	II	6
31-33	—	Not determined.	-	-
34-35a-b	3021	<i>Amplexus</i> cf. <i>lojopingensis</i> Grabau 3 fragments.	-	-
35	3022	Ibid. longitudinal section (35 a-b)	III	19
36	3023	Ibid. transverse section 34 & 35.	III	17
37	3024	<i>Cystiphyllum omphymiformis</i> Gr. (with 40) fragments	-	-
38	3025	<i>Omphyma glomerata</i> Gr. fragment	-	-
39-40	—	Not determined.	-	-
41	—	<i>Spirifer tingi</i>	-	-
42	3026	<i>Cystiphyllum</i> sp. longitudinal section	III	16
42a-b	3026	Ibid. fragments of same.	-	-
43	—	not determined.	-	-
44	3027	<i>Amplexus</i> cf. <i>lojopingensis</i> cross section slide.	III	18
45	3028	<i>Cystiphyllum</i> sp. (not described)	-	-
46	3029	<i>Favosites forbesi</i> var. <i>kweilungensis</i> longitudinal section.	-	-
47	—	not determined.	-	-
48	3030	<i>Cystiphyllum omphymiforme</i> Gr. cross section. holotype.	III	15
49	3031	Ibid. section of another specimen (lower end No. 37)	-	-
50	3032	Ibid. section just below calyx of holotype.	III	14
51	3033	Ibid. section of another specimen (upper end No. 37)	-	-
52-53	3034	<i>Cystiphyllum omphymiforme</i> Gr. Holotype section fragments.	-	-
54	3035	Ibid. longitudinal section holotype.	III	13
55	3036	<i>Cystiphyllum omphymiforme</i> Gr. calyx Holotype (52-53).	-	-

FAUNAL SUMMARY

The species of corals here described comprise the following.

1. *Favosites forbesi* E. & H. var. *kweitungensis* Grabau
2. *Omphyma glomerata* Grabau.
3. *Omphyma cystiphyllodes* Grabau.
4. *Cystiphyllum omphymiforme* Grabau.
5. *Cystiphyllum* sp.
6. *Amplexus* cf. *lojopingensis* Grabau.

With these corals occur numerous well-preserved specimens of *Spirifer tingi* Gr. and several other brachiopods of undescribed species. Also a species of *Holopea*, probably *H. yilungensis* Gr.

Though not large, this fauna is distinctive and consists of typical Silurian forms.

The *Spirifer tingi* beds were first recognized as a part of the *Miaokao* group in the Chütshing region of East Yunnan, where these beds overlie the Lower Silurian *Mientien* group disconformably, and have an exposed thickness of 165 metres. The fauna in the typical section at Yilung comprises the following species¹.

ANTHOZOA.

Cladopora kütsingensis Grabau

BRACHIOPODA

Camarotoechia cf. *tongkinensis* Mans.

Spirifer (*Eospirifer*) *tingi* Grabau.

PELECYPODA

Pterinea mientienensis Grabau

Actinopteria mansuyi Grabau

Modiolopsis miaokaoensis Grabau

Modiolopsis sp.

Leda yilungensis Grabau

Praecardium distans Grabau

GASTROPODA

Hormotoma kütsingensis Grabau

H. kütsingensis var. *major* Grabau

Holopea yilungensis Grabau

1. Grabau. Silurian fauna of Eastern Yunnan. Pal. Sinica, Series B, Vol. III, Fasc. II.

OSTRACODA

Leperditia tingi Grabau*Leperditia* sp.*Eutomis ? corduroides* Grabau

In the East Yunnan region, the *Spirifer tingi* beds are overlain by the *Spirifer bourgoisi* beds, and these by higher beds with *Ceratiocaris*, while still higher beds with fish remains succeed these. None of these higher beds however, have so far been found in Kweichow. The stratigraphy is given in the following note by V. K. Ting.

NOTES ON THE STRATIGRAPHY OF THE *SPIRIFER TINGI* BEDS OF KUEITING.

By V. K. TING.

The corals described by Dr. Grabau in the preceding pages came from a place 750 m W. of the village of Machiat'un, which is situated 11.7 kilometers east of the district city of Kueiting in Kweichow province. The specimens from locality T107 were found *in situ* and those from T107a were collected from the slabs used for pavement right besides locality T107.

The fossiliferous bed is a thin-bedded greenish impure limestone intercalated in reddish and greenish sandstone and shale. Its relation with the other strata is showing in the following section.

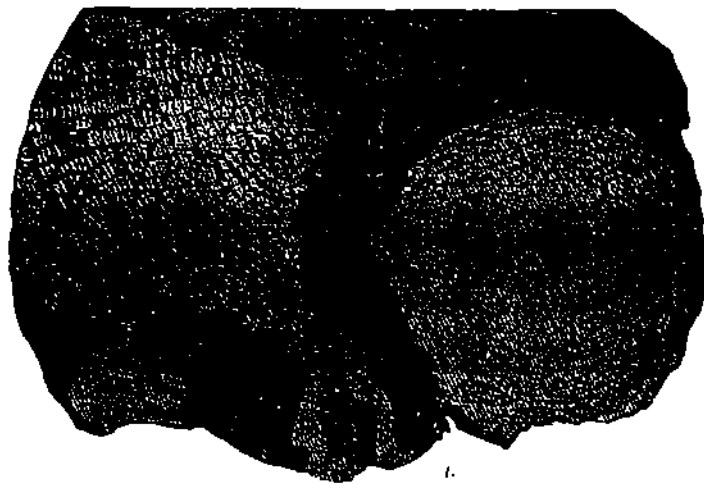


The limestone in the neighbourhood of Tungshang'ing contains Ostracods, of Lower Carboniferous age. East of Tungshang'ing this is underlain by a massive brown quartzitic sandstone about 400 m thick which overlies a series of soft reddish and greenish sandstone and shale. From the contact of the latter with the quartzite to the thin limestone bed containing *Spirifer tingi* the thickness is about 450 m. The quartzite is Devonian as typical Devonian fossils were found in the limestone beds in it further south. The age of the red and green sandstone and shale is not certain, but as it seems to form a continuous series with the *Spirifer tingi* bed, it is assumed to be also Silurian.

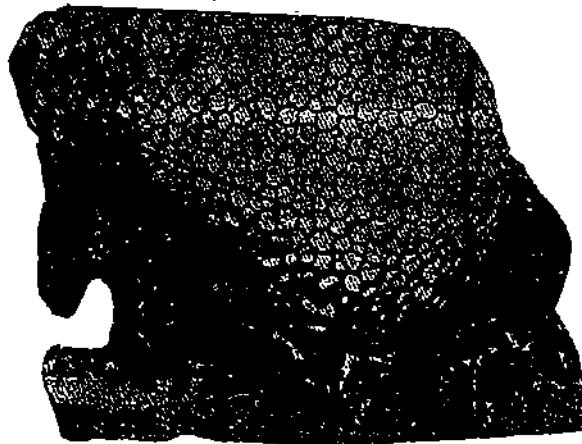
So far all the formations described have a general strike of NNE—SSW dipping 20° WNW. East of Machiat'un however the strike becomes WNW—ESE dipping about 22° NNE, so that in the section given above the dip becomes quite gentle. In going down hill from Machiat'un the following detailed section was observed:—

EXPLANATION OF PLATE I

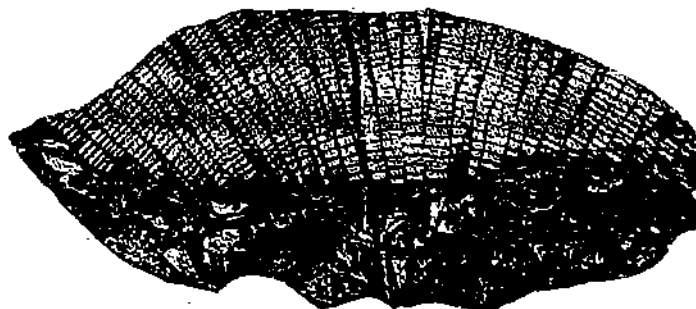
- Fig. 1. *Favosites forbesi* E. & H. var *kweitungensis* Grabau page 223
transverse section of a subspherical individual, together with
a transverse section of another. Both $\times 2$, Slide 8, Cat G. S. C.
3,005.
- Fig. 2. *Favosites forbesi* E. & H. var *kweitungensis* Grabau page 223
Cross section of another larger individual showing the varying
character of the corallites. $\times 2$, Slide 17; Cat G. S. C. 3,009
- Fig. 3. *Favosites forbesi* E. & H. var *kweitungensis* Grabau page 223
Longitudinal section of a hemispherical fragment, showing the
relation of the corallite and the tabulae. $\times 2$; Slide 15
Cat. 3,007.



1.



2



3

**Explanation of
Plate II**

EXPLANATION OF PLATE II

- Fig. 4. *Favosites forbesi* E. & H. var. *kweitungensis* Grabau page 223
Longitudinal section, showing the crowded corallites in the upper part, $\times 2$. Slide 18. Cat. 3,010
- Fig. 5. *Favosites forbesi* E. & H. var. *kweitungensis* Grabau page 223
Section of a larger head, passing longitudinally through the corallites in the upper part, but obliquely below. Slide 9. Cat. 3,003.
- Fig. 6. *Omphyma glomerata* Grabau page 227
Transverse section of a large corallum with 3 buds on the inside on one side, and showing coarse cysts and septal ridges $\times 2$. Slide 30. Cat 3020.
- Fig. 7. *Omphyma glomerata* Grabau page 227
Longitudinal section showing two nearly complete corallites and a fragment of a third $\times 2$. Slide 29. Cat. 3019.
- Fig. 8. *Omphyma glomerata* Grabau page 227
Longitudinal section of another group showing 3 corallites, the section passing nearly medially through the left hand one, but obliquely through the other two $\times 2$. Slide 28. Cat. 3018.



5



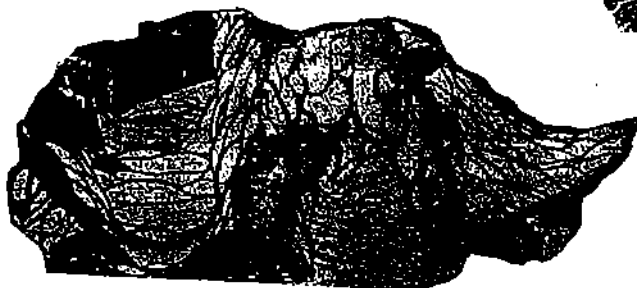
4



7



6



8

**Explanation of
Plate III**

EXPLANATION OF PLATE III

- Fig. 9. *Omphyma cystiphylloides* Grabau page 230
Longitudinal section of specimen 19 a-b, showing part of the calyx, the coarse cysts and the thickened layers. Associated with a fragment of *Favosites forbesi* var. *kweitungensis*. Slide 21. Cat. 3014 x 2.
- Fig. 10. *Omphyma cystiphylloides* Grabau page 230
Another longitudinal section of the same specimen, taken at right angles to the preceding. x 2. Slide 23. Cat. 1316.
- Fig. 11. *Omphyma cystiphylloides* Grabau page 230
Longitudinal section of another individual (specimen 20) x 2. Section 22. Cat. 3015.
- Fig. 12. *Omphyma cystiphylloides* Grabau page 230
Cross-section of specimen 19 a-b. Incomplete on two sides. x 2. Section 19. Cat. 3011.
- Fig. 13. *Cystiphyllum omphymiforme* Grabau page 233
Longitudinal section of the holotype (specimen 52-53) x 2. Slide 54. Cat. 3035.
- Fig. 14. *Cystiphyllum omphymiforme* Grabau page 233
Transverse section of the holotype just below the calyx. The dark part shows a portion filled with mud. x 2. Slide 50. Cat. 3032.
- Fig. 15. *Cystiphyllum omphymiforme* Grabau page 233
Another cross-section of the holotype x 2. A few faint septal ridges are indicated on some of the inner cysts. Slide 48. Cat. 3013.
- Fig. 16. *Cystiphyllum* sp page 235
Longitudinal section of the specimen described. x 2. Slide 42. Cat. 3026.
- Fig. 17. *Amplexus* cf. *lojopingensis* Grabau page 235
Transverse section of specimens 3435 across calyx in which lies a small *Holopea*. Septal ridges and external septal grooves are shown. x 2. Slide 36. Cat. 3023.



10



9



14



21



12



15



12'



11



12''



26



EXPLANATION OF PLATE III (Cont.)

- Fig. 18. *Amplexus cf. lojopingensis* Grabau. page 235
Cross-section of another individual showing the short septa
× 2. Slide 44. Cat. 3027.
- Fig. 19. *Amplexus cf. lojopingensis* Grabau page 235
Longitudinal section of the lower part of the section from
which fig. 17 was cut, showing the distant tabulæ and a
suggestion of a root-like extension on one side. × 2. Slide 35.
Cat. 3022.