

THE EARLY MIDDLE DEVONIAN BRYOZOANS FROM WUTSUN SHALE, KWANGSI.

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INTRODUCTION

The material dealt with in this paper came from the upper part of the Wutsun shale near Liuchingyu. The village is located on the right bank of Yukiang, about 12 km. to the north of Yungchun city. The Wutsun shale consists mainly of shales and sandstones with a bed of argillaceous limestone in the upper part varying from a few to 15 meters thick. The bryozoans occur in the uppermost part of the formation, where the rock contains high iron contents. They are associated with numerous corals and brachiopods. The following forms are most characteristic among them: *Caleceola sandalina* Lamarck, *Spirifer speciosus* auct., *Kwangsia yohi* (Grabau), *Plectospirifer fongi* Grabau, *Stropheodonta amnamitica* (Mansuy), *Thiemilla communis* Yin and *Proetus indosinensis* Mansuy. The lower part of the Wutsun shale grades downward into sandy beds and finally into median grained to coarse sandstone called the Hsiaoshan sandstone. The Wutsun shale is succeeded by the Tungkangling limestone with *Stringocaphalus burtini* Defr., a leading fossil of the upper part of Middle Devonian corresponding to the Givetian of Europe. According to the fossils listed above, it is evident that the Wutsun shale belongs to the early Middle Devonian corresponding to the Eifelian of Germany. The material consists of 9 new species in 3 different genera, among which *Fistulipora*, including 7 species, is the most abundant form both in species and in individuals. Three different zoarial types are recognized, namely, the thick laminar to massive, the encrusting and the hollow ramose types; while the solid ramose forms have not been seen in the present collection. Some of the specimens are very well preserved; the preservation of other specimens leaves much to be desired.

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DESCRIPTION OF SPECIES

Order Cyclostomata Busk

Family Fistuliporidae Ulrich

Genus *Fistulipora* McCoy

Fistulipora kwangsiensis Yang (sp. nov.)

Pl. I, Figs. 1a, 1b,

The zoarium representing this species is an elongate hemispherical mass, having a flat or slightly concave base that reveals successive growth laminae but no visible epitheca. The surface is strongly convex; the best preserved specimens show very gently rounded, low but distinct monticules, 5 to 7 mm apart. The apertures of the zooecia are circular to subcircular in cross section and moderately spaced, 6 in a distance of 2 mm. The diameter of the larger zooecia is 0.33 mm, while that of the small ones is 0.23 mm. The lunaria which are visible only in a few less worn areas, are very faint and small, not appreciably inflecting the zooecial wall.

In tangential sections the zooecia are separated by one to three rows of vesicles which are irregular in size and form. The zooecial walls are thin, but slightly thickened at the piace, where the lunaria are developed occupying less than one-fifth of the zooecial circumference. In longitudinal sections the zooecial tubes appear remarkably regular in counter, straight walled with a few diaphragms, two or three tube diameters apart. Curved diaphragms or cystiphragms, closed at one side of the zooecial walls, are prominent characters in some of the zooecial tubes. One to three rows of vesicles which look like mesopores of some of the Trepostomata, are present between the zooecial tubes.

The present species resembles the Carboniferous species *Fistulipora candidia* (Moore et Dulley) of the Coal Creek limestone, Kansas, U. S. A., but differs in tangential section in the presence of faint lunarium, instead of strong and prominent one. In longitudinal section, the present species possesses cystiphragms or curved diaphragms, but no cystiphragms have ever been detected in *F. candidia*.

Horizon and Locality: Wutsun shale, early Middle Devonian; one km. east of Liuchingyu, Yungchun, Kwangsi Cat. No. 7164.

***Fistulipora irregularis* Yang (sp. nov.)**

Pl. I, Figs. 2 a—2c

This species is established basing upon a single irregular mass 80 mm in length and 40 mm in width, bearing knobs, stubby branches and depressed areas; distinct maculae measured 5 mm apart, from center to center, are the surface characters. The zooecial apertures are regularly spaced, separated by interspaces as long as their own diameter; they are circular to subcircular in outline.

In tangential sections the zooecial tubes are circular to oval in transverse section; they are separated by one to two or rarely three rows of vesicles which are irregular in size and form. At the monticules the zooecia are few or wanting, where only large vesicles are aggregated. Lunaria absent. The diameter of the larger zooecia is 0.33 mm, that of the small ones is 0.33 mm. In longitudinal sections the zooecial wall is thin, the zooecial tubes are curved. Remote thin irregular spaced horizontal or curved diaphragms insert the zooecial tubes which are separated mostly by one or two rarely three rows of vesicles. Zonal structure separated by solid substance is a conspicuous character of this species.

The complete absence of lunarium, the comparatively larger size of vesicles, the slightly curved zooecial tubes and the zonal structure are characters that distinguish the present species from the preceding species. In addition, there are 5 zooecia in a distance of 2 mm instead of 6 zooecia in the same distance.

Horizon and Locality: same as the preceding species. Cat. No. 7165.

***Fistulipora hemispherioidea* Yang (sp. nov.)**

(Pl. I, Figs. 4a, 4b; Pl. II, Fig. 1)

A hemispherical rounded massive zoarium, 60 mm in width and length, 35 mm in height, with a gentle convex top and a nearly flat base which appears in some part to be epitheated, represents the character of the present species. The surface of the zoarium is marked by low upswellings, 4 or 5 mm apart. Zooecial apertures, ordinarily five in a distance of 2 mm, are circular in outline.

In tangential sections the zooecial tubes are circular to subcircular; in transverse sections the zooecial walls are thin and the distribution of zooecia is not regularly spaced, in some areas the zooecia are connected together, while others are separated by a distance as long as their own diameter. The interspace between the zooecia is occupied by one, rarely two rows of vesicles irregular in

form and size. The diameter of the larger zooecia is 0.36 mm, that of the small ones is 0.18 mm, the ordinary one is 0.28 mm. The very slightly thickening of some of the zooecial wall on one side may represent the development of lunarium. In longitudinal sections the zooecia are crossed by remote diaphragms, about one tube diameter apart in the peripheral region; two, three or four diameters apart in the immature zone. Long curved diaphragms are occasionally present in some of the zooecial tubes in the mature region.

The irregular distribution of the zooecia, in some areas the zooecia are connected together, in others they are separated far apart is the conspicuous character of this species. The flat hemispherical or cake shaped zoarium may readily be distinguished from all the associated forms.

Horizon and Locality: same as the preceding species. Cat. No. 7166.

***Fistulipora yungchunensis* Yang (sp. nov.)**

(Pl. II, Figs. 3 a—3c)

Zoarium belonging to this species is parasitic, as thick incrustation on a brachiopod shell. The thickness of the holotype ranges from 1 mm to 10 mm. The surface of the zoarium, roughly speaking, is smooth; maculae measuring 5 mm apart from center to center, are not conspicuous characters of this species. The zooecial apertures are circular in outline, without any indication of development of lunaria.

In tangential sections the zooecial tubes, separated by one or two rarely three series of vesicles, are circular to subcircular in transverse sections. Zooecial wall thin. The diameter of the zooecia measured about five to six in a distance of 2 mm, ranges from 0.23 to 0.29 mm with an average of 0.26 mm. Lunaria are unrecognized. No zooecia are developed at the maculae, where only vesicles are aggregated. Straight or curved lines representing the cystiphragms or curved diaphragms cross some of the zooecia. A few growth laminae can be distinguished in longitudinal sections, and the zooecial tubes filled with one or two and sometimes one large curved diaphragms, do not pass through them. The zooecia are separated by one to six rows of vesicles which are elongated laterally or longitudinally.

The present species resembles *Fistulipora kwangsiensis* in internal structure but differs from it in the parasitic mode of growth.

Horizon and Locality: Same as the preceding species. Cat. Nos. 7167-7168.

***Fistulipora lamellosa* Yang (sp. nov.)**

(Pl. II, Figs. 2a, 2b)

Zoaria belonging to this species are irregularly rounded or nodular masses. The type specimen, with a slightly concave upward base, is 40 mm in width, 35 mm in height and thickness. The colonies are compact and are built up by laminae that form a strongly convex zoarium. The surface lacks distinct monticules; maculae 3 mm apart being developed. The zooecial apertures are circular to subcircular in outline, and are separated by vesicles closed at the surface.

In tangential sections the zooecial tubes are mostly oval or subcircular in cross section and are separated by one or two rows of vesicles irregular in form and comparatively small in size. The zooecial walls are thin, slightly thickened only at the small end of the oval zooecia that represents development of the faint lunarium occupying one fifth of the zooecial circumference. The diameter of the lunarium seems to be shorter than that of the zooecium. The longer diameter of the zooecia is usually 0.41 mm; the short one is only 0.26 mm. Zooecia are not uniformly spaced; five and a half zooecia are counted in a distance of 2 mm.

In longitudinal sections the most striking feature is the laminated growth, 3 in a distance of 2 mm. The zooecial tubes filled with one or two horizontal diaphragms and sometimes one large curved diaphragm, do not pass through the laminae. One to three series of small vesicles lie between the zooecial tubes which are sometimes irregular in counter due to the inflation of the vesicles. The zooecial tubes are not always straight; they are sometimes oblique and sometimes curved at the lower part of each lamella.

This species is readily distinguished by the lamellate growth and the ovate zooecia from all the other species described in the present paper. It resembles *F. multilamella* Nehorshev, a Devonian species of U. S. S. R., but differs from it in the smaller size of vesicles.

***Fistulipora ovata* Yang (sp. nov.)**

(Pl. III, Figs. 1a, 1b)

This species is represented by a single specimen of an irregularly ramose zoarium with short stout and hollow branches. The thickness of the zoarium varies from 1.5 mm to 10 mm. No monticules or maculae are recognized on the surface, only depressions of clusters which are aggregated by groups of vesi-

cles, are detected at a distance 5 mm apart measured from center to center. Zooecial apertures separated by grooves are oval or elliptical in outline and bordered at the posterior end by lunaria slightly higher than the ordinary surface.

In tangential sections the zooecia are oval in cross section, arranged in series and separated by a single series of large vesicles. The longer diameter of the zooecia is 0.33 mm and the shorter one is 0.20 mm. The distances between the zooecia are very variable ranging from 0.086 mm to 0.30 mm, as a whole, they are nearer along the longer diameter of the zooecia and further along the shorter one. Five zooecia are counted at a distance of 2 mm. The lunaria are very small, located at the small end of the zooecia and are recognized by the slight thickening of the zooecial walls.

In longitudinal sections the zooecial tubes are separated by one to three rows of vesicles and filled with diaphragms, two or three diameters apart. The zooecia are uniformly thin-walled, the walls are straight on one side and bounded on the other by protruding surface of vesicles.

The elongated oval zooecia seen in tangential sections resembles those of *F. lamellosa* (sp. nov.) but differ in the larger form and in the fewer vesicles. In longitudinal sections the zooecial tubes are long and nearly straight and separated by one to three rows of large vesicles; while in *F. lamellosa* they are short, never passing through the lamellae and are separated by small vesicles.

Horizon and Locality: Same as the preceding. Cat. No. 7170.

***Fistulipora chaoi* Yang (sp. nov.)**

(Pl. III, Figs. 2a—2d)

A hollow ramose zoarium irregular in shape and branching is attributed to this species. The surface exhibits maculae or cluster, 3 mm apart measured from center to center. The apertures of the zooecia are circular to oval in outline and arranged in series that are accentuated by the grooves, like the depressions of the interzooecial areas. Peristome high; lunarium obsolete; 6 to 5 apertures in a distance of 2 mm.

In longitudinal sections the zooecia, developed from a wrinkled epitheca, extend nearly parallel to the epitheca for a long distance and then bend abruptly towards the surface. The immature region is comparatively shorter than the mature region. Walls very thin in the axial region and slightly thickened in the periphery. One or two diaphragms usually present at the transitional region

insert the zooecial tube. Vesicles separating the zooecia are prominent characters. Tangential sections show that the subcircular or oval zooecia are not uniform in size; their diameters range from 0.22 mm to 0.31 mm, with a posterior small arch which represents the development of lunarium. The zooecia at ordinary area are separated by one to two rows of vesicles which are not uniform in size and form. The macular area is occupied by vesicles only.

This hollow ramose zoarium can readily be distinguished from all the other species described in this paper, except *F. ovata*. It can easily be distinguished from the latter by the subcircular instead of elongated oval zooecia. In longitudinal sections the present species bears curved zooecial tubes, while the zooecial tubes of *F. ovata* are nearly straight.

Horizon and Locality: Same as the preceding species. Cat. Nos. 7171-7172.

Order Trepostomata Ulrich

Family Heterotrypidae Ulrich

Genus *Leptotrypella* Vinassa de Regny

***Leptotrypella kwangsiensis* Yang (sp. nov.)**

(Pl. II, Fig. 5; Pl. III, Fig. 5)

This species is represented by a ramose slender dichotomously branching zoarium with smooth branches 4 to 6 mm in diameter. The surface is smooth without monticules or maculae but groups of larger than the average cells, 2 mm apart, measured from center to center, may be detected. Zooecia polygonal, thin-walled, 7 in a distance of 2 mm; mesopores generally wanting; few small tubes associated with large zooecia present; acanthopores not seen on the external surface.

Longitudinal sections: zooecial walls thin in the immature region, moderately and occasionally irregularly thickened in mature zone, and bend gradually from the axial region toward the periphery and direct to the surface. No diaphragms developed at both the axial and the peripheral zone, while on the transitional zone, the early mature zone, one or two rarely three diaphragms are inserted in each zooecial tube at a distance about their own diameter.

Tangential sections: zooecia polygonal; walls thick; thin light-colored divisional band nongranular. Acanthopores obscure, few in number, small in size, generally present at the junction angles. Mesopores absent, a few small zooecia present at the vicinity of clusters.

The extremely small acanthopores seen in tangential section can easily be

distinguished from those of *Leptotrypella ohioensis* (Stewart) which bears well defined and moderately sized acanthopores, though their longitudinal sections are similar. It differs from *Eridotrypa parvulipora* Ulrich et Bassler in the comparatively longer mature zone and in the zooecial tubes nearly perpendicular to the surface. The latter species is characterized by a short mature zone and oblique zooecial tubes.

Horizon and Locality: Wutsun shale, early Middle Devonian; one km. east of Liuchingyu, Yungchun, Kwangsi. Cat. No. 7173.

Family Batostomellidae Ulrich

Genus *Eridotrypa* Ulrich

Eridotrypa sinensis Yang (sp. nov.)

(Pl. II, Figs. 4a, 4b; Pl. III, Fig. 4)

Zoarium more or less irregularly ramose, the branches sometimes being sub-cylindrical and irregularly divided but often consisting of gnarled stems irregular in shape. Diameters of the branches vary from 12 mm to 20 mm. Surface more or less smooth, maculae of zooecia larger than the intermacular spaces are present; some of the maculae occasionally being elevated. Zooecia polygonal, 7 in 2 mm, both mesopores and acanthopores are absent.

Longitudinal sections: zooecia bend very gradually from the axial region toward the periphery, slightly oblique in the mature region. Zooecial walls thin, crenulated and granular in the axial zone, gradually thickened in the transitional zone, clearly laminated and occasionally intermittently thickened, somewhat massive or fused together in the short mature zone. Diaphragms 3 to 4 tube diameters apart in the axial region, one tube diameter apart in the early mature region, usually absent in the later mature zone.

Tangential sections: zooecial walls thick, when the sections are cut near the surface and leave the apertures rounded or oval; thin and polygonal, when the sections are cut a little farther downward from the surface. The intermittently thickening of the walls and a faint dark dividing line separating the adjacent zooecial walls can also be seen in these sections. Mesopores generally absent, small zooecia may be detected only near or at the maculae. A few very small acanthopores or granular spots present at the junction of walls.

The tangential sections of the present species resemble those of *Eridotrypa aedilis* (Erchwald), an Ordovician species, but the longitudinal sections differ

from it in the fewer diaphragms at the axial region and the crinkled zooecial walls surrounded by granular deposit. Externally it is a stout irregular ramose zoarium with a diameter more than 12 mm instead of having a long slender form with a diameter only 5 to 6 mm. It can be distinguished from *Eidotrypella oblique* (Ulrich) by the absence of mesopores and typical acanthopores. In some respects it resembles *Eridotrypella* Duncan and *Leptotrypella* Vinassa de Regny (emended by Bassler); it differs from the former in the absence of transverse rows of granules, and from the latter in the absence of typical acanthopores and oblique zooecia. Both the former and the latter species have heterotrypid-walls, while the present species bears characters of Batostomellida.

Horizon and Locality: same as the preceding species. Cat. No. 7174.

Order Cryptostomata Vine

Family Fenestellidae King

Genus *Fenestella* Lonsdale

***Fenestella* sp.**

(Pl. I, Fig. 3)

The zoarium of this species is unknown, only a flattened fragment attaching to a *Fistulipora* is recognized. The branches are angular, 4 occurring in a distance of 2 mm; The width of their diameter averages at 0.20 mm. Dissepiments are narrow, rounded and much depressed below the plane of the branches. Fenestrules appear to be quadrangular, 3 in a distance of 2 mm. Apertures bearing low peristomes and opening directly to the surface, circular in outline and moderate in size, are separated by distances approximately equal to their own diameter. The diameter of the zooecia averages at 0.10 mm. Three apertures may be detected in each fenestrule. Carinae are very slender and slightly higher than the plane of the branches. Only the obverse is known, the reverse is not shown in this specimen.

Horizon and Locality: Same as the preceding. Cat. No. 7175.