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Redescription of *Ischadites koenigii* Murchison, 1839

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Murchison's (1839, pp. 697–698) original spelling of the name is *Ischadites Königii*. It is here spelled *Ischadites koenigii*.

INTRODUCTION

This paper is a part of the larger study of the revision of North American receptaculitids. Receptaculitids are dasycladacean algae and consist of three taxa: cyclocrinitids, calathiids, and receptaculitids proper (Nitecki, 1967b, 1968). Receptaculitids consist of two genera, *Receptaculites* and *Ischadites*. Cyclocrinitids have been monographed (Nitecki, in press) and the work on calathiids and receptaculitids has begun.

The genus *Ischadites* Murchison, 1839, is difficult to distinguish from the genus *Receptaculites* as defined by Deshayes, 1828. The similarities and the differences between these two genera are of nomenclatural importance but have been greatly confused. In order to resolve the taxonomic problem it became necessary to redefine the genus *Ischadites*. This paper, therefore, constitutes a redescription of *Ischadites koenigii* based upon the original and comparative material from England. However, it is not a systematic revision of all forms of *koenigii*.

HISTORICAL SKETCH

Murchison (1839, pp. 697–698) described *Ischadites koenigii* as follows: "These curious fossils are so grouped together, that I always compared them with 'packed or pressed figs'; and Mr. König, to whom I referred them, thus speaks of them. 'I am of opinion that they may be considered to belong to the family of *Ascidiae*. Like

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FIG. 1. Reproduction of Murchison's (1839) illustration of *Ischadites koenigii*. × 1.

the *Leucophthalmus* of the Icones Sectiles, they seem to form a group of globular, coriaceous, and, it may be added, pedicled bodies, for in one of them the cicatrix for the insertion of the pedicle distinctly appears. As, however, no traces of branchial and intestinal apertures are apparent on the surface exposed to view, it would be rash to constitute this fossil a genus, or to assign it a place in any of the known genera of the order of the naked Mollusca, to which *Leucophthalmus* unquestionably belongs.'

"Unable to acquire more knowledge concerning the affinities of this fossil, I simply refer to the figure, in which the beautiful tessellation of its surface is expressed; and feeling that any name, which does not mislead, is better than no name, I have called it *Ischadites* from ισχας, a dried or potted fig, the specific name being furnished by my friend Mr. König, who, as above stated, has described animals somewhat analogous."

His illustration is reproduced here as Figure 1. He reproduced his figure in subsequent editions of his work as a probable Cystidean but without additional information. In the third edition of *Siluria*

Murchison (1859) considers *Receptaculites* from Canada to be allied to Orbitolites (pp. 466, 468), without noting the relationship of *Receptaculites* to *Ischadites.*

Hinde (1884) reviewed the literature on receptaculitids and redescribed *Ischadites* as a sponge. The more recent literature upon the nature of *Ischadites* is discussed in a paper by Kesling and Graham (1962) who considered it to be an alga. The American literature of Ordovician and Silurian receptaculitids is reviewed by Rigby and Nitecki (1968).

Terminology

The terminology used in this paper is that of Nitecki (in press) and is as follows: *Main axis* is a central vesicle, central axis, or a central body, not calcified in *I. koenigii.* In other receptaculitids the main axis extends into a *stem,* which is absent in *koenigii. Laterals* or lateral branches are of the first degree only. *Lateral heads* are enlarged, dilated, cortical cells modified to form stellate structures and facets.

Fig. 2. The cast of *Ischadites koenigii* Murchison, 1839, based upon Geological Survey Museum specimen no. 6551. × 1.

Stellate structures consist of four rib-like projections immediately below the facets and forming a skeletal network of the thallus. *Facets* are rectangular areas on the surface.

Description of Murchison's Type Specimens

The slab of rock containing the original specimens of *Ischadites koenigii* upon which Murchison based his description and illustration is in the Geological Survey and Museum in London and is numbered "GSM Geol. Soc. Coll. 6551." The latex mold of this specimen was secured and the cast was subsequently made. The cast is illustrated in Figure 2. The following discussion is based upon interpretation of the cast and upon the comments of A. W. A. Rushton of the Geological Survey. Rushton (personal communication) described the original as follows: "Most of the specimens on the slabs are low ornamented humps and are slightly darker in color than the silty matrix surrounding them. Murchison's figure [fig. 1] is not identical with the type specimen [fig. 2]; a large specimen in the middle, is the large specimen in the top left corner of Murchison's figure; the good oval specimen below this one [in Murchison's figure] and the Orbiculoidea (top right corner) can also be matched satisfactorily. The cast covers only about half the slab, but the other half has only obscure specimens on it."

There are ten specimens on the cast, only two of which are complete and adequately preserved to allow for the detailed description. The fossil in the middle seems flattened and is not uniformly preserved. Its relatively robust shape does not appear altered by postmortem conditions. The facets are greatly worn at the growing point of the plant and somewhat less at the base. The best preservation occurs in the widest part of the specimen.

The fossil below it is much better preserved. It is ovoid in shape with the growing point narrower and somewhat pointed. The upper, growing point (in the photograph oriented to the left) is clearly observable and the faceted surface is arranged in lines radiating away from the tip. These lines are formed by the fusion of edges of the rhomboidal facets in contact. Stellate structures are observed on the lower portion of this specimen and on surfaces of certain other individuals. These are four regular, short, relatively robust outgrowths of the terminus of the lateral branch that terminate in four corners of the facet and often two of these are somewhat higher than the other two. They are commonly preserved as molds. These, when present in many facets, form lines intersecting the diagonal lines formed by the facetal contacts. The details of the growing tip are

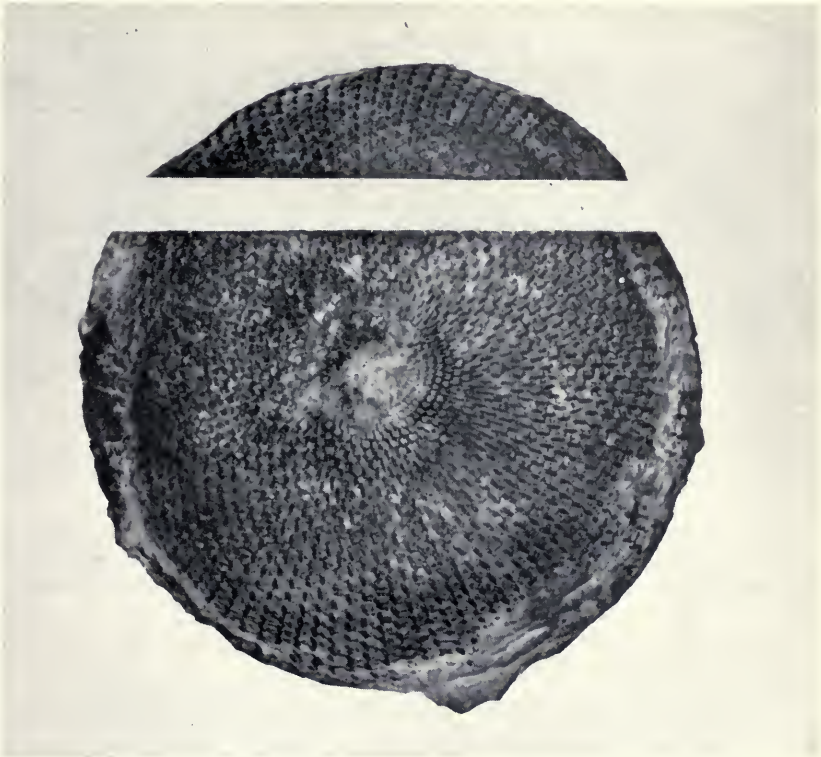

FIG. 3 The apical view of *I. koenigii*, P. 4232. The growing point is not preserved; the spiral growth, however, is seen. The pattern of lines upon the surface is formed by the ribs of stellate structure. × 2.2.

obscure, however, the surface of thallus that is almost below the growing tip is preserved and shows the regularity of arrangement of facets. No main axis is preserved on any specimen, neither is any attachment pedicle or stem observed. No laterals, except their terminal elements are preserved.

The thalli are not oriented in their growth position, but are overturned and may have been moved about the substrate. The associated brachiopod is the branchial valve of *Orbiculoidea* sp.

Comparison with American Specimens

The study of American representatives of *I. koenigii* will be published elsewhere (Nitecki, 1969a). It suffices to say at the present time that in North America many specimens, particularly the Niagaran fossils from the Midwest, are indistinguishable from the British

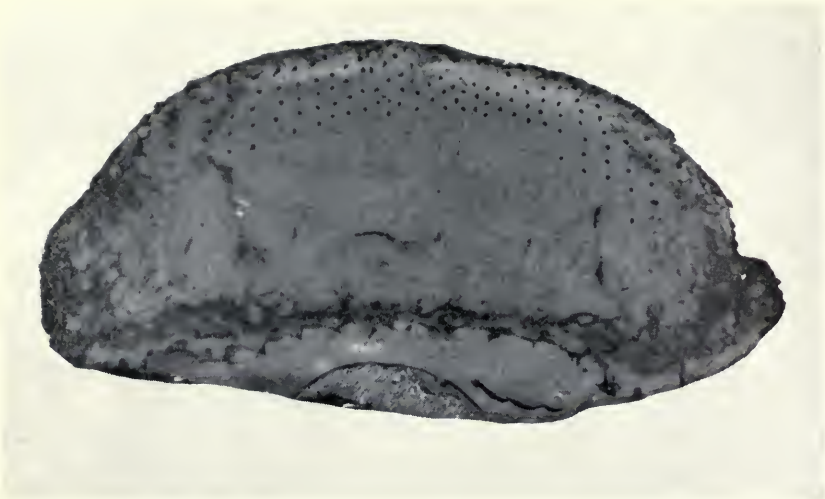

FIG. 4. Vertical cross-section of thallus of *I. koenigii*, P. 4232. Small dots in the upper part are laterals. These are blackened to intensify their appearance. The area below the horizontal line is matrix. Right side edge of thallus is deformed. × 3.

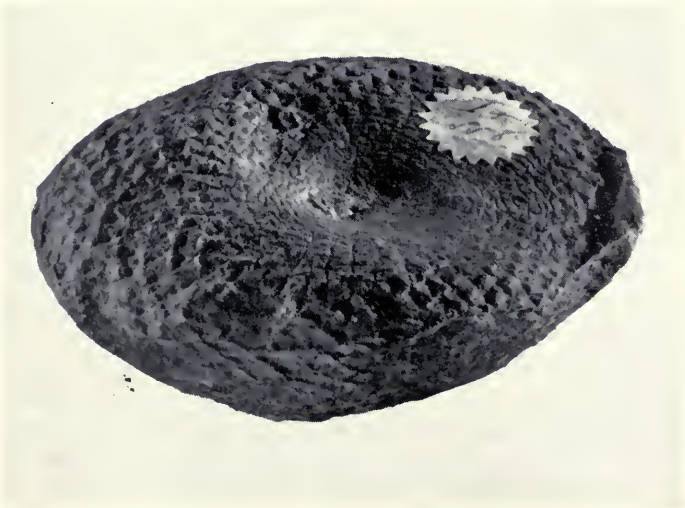

FIG. 5. Apical view of *I. koenigii*, S. 3772. The elongate, ovoid thallus is somewhat collapsed. The largest facets are just above the "equatorial" region. × 1.25.

koenigii. In addition, in North America many species have been named that are probably junior synonyms.

SYSTEMATIC DESCRIPTION

Chlorophyceae

Siphonocladiales

Definition.—"Plants uni- or multicellular, simple or branched, the branching irregular, or lateral from a primary axis, or organized in two or three planes into specialized thallus structures; cells generally multinucleate, with a net-like chromatophore or many disk-like chromatophores; pyrenoids usually present." (Taylor, 1960, pp. 96–97.)

Dasycladaceae

Definition.—"Plants each composed of a long axial cell attached to the substratum at the base by rhizoidal outgrowths, and bearing regular whorls of simple or forked branchlets of limited growth; reproduction by aplanospores or cysts, which in turn produce gametes." (Taylor, 1960, p. 97.)

Tribe Receptaculiteae trib. nov.

Definition.—Thallus globose, elongate, conical, or disc shaped; shape of thallus may have been ecologically controlled; diameter of thallus up to 40 cm.; main axis non-calcified, weakly calcified or absent; when present elongate and thin, or short and globular; first degree laterals only; laterals in whorls; all branches within whorl same length; laterals expand and form calcified lateral heads; stellate structures almost always present; almost complete incrustation with calcium carbonate; precipitation of second layer of $CaCO_3$ and formation of second wall common; solitary and marine; cosmopolitan; Ordovician to Devonian.

Genus *Ischadites* Murchison, 1839

Definition.—Shape of thallus varies, generally globose; main axis globular or elongate, rarely calcified; proximal ends of laterals non-calcified; stellate structures and facets present; stellate structures four-ribbed; facets above stellate structures rarely calcified; growth irregular or spiral or both; attachment organs short rhizoids or absent; Middle Ordovician to Middle Devonian.

Discussion.—The first discovery and description of receptaculitids, under the name *Receptaculite* (ICZN pend., Nitecki, 1967a)

was made by Defrance (1827) who described and figured two specimens from Devonian in the neighborhood of Chimay, Belgium. The examination of Defrance's illustrations and text reveals that *Ischadites* may be a synonym of *Receptaculites*. However, conclusions on the validity and priority of the name *Ischadites* has to be postponed until the type specimens of *Receptaculites*, or material from Defrance's documented stratigraphic and geographic location is studied.

Ischadites koenigii Murchison, 1839

Definition.—Thallus globular to discoidal; main axis non-calcified; laterals thin, distally calcified, borne in tightly-packed whorls; stellate structures heavily calcified; facets weakly calcified, four-sided; largest facets in lower part of thallus; growth spiral, new laterals regularly added apically and sometimes at random; attachment basal; Silurian; England.

Material.—All specimens are Silurian from England. Measurements are given in Table 1.

TABLE 1.—Measurements in centimeters of 13 specimens of *I. koenigii*. In all cases the longest dimension is given. (P. 7051 consists of two flattened-out and incomplete specimens; P. 3786 is flattened-out and incomplete; and P. 4241 is flattened-out).

	Height	Width		Height	Width
BMP. 4232	1.64	3.75	GSM 6551	3.14	2.43
BMP. 7051	—	6.53		3.81	3.54
BMP. 7051	—	5.34		3.77	2.98
BMS. 3786	—	8.90		4.30	3.02
BMS. 3772	2.50	6.59		—	3.26
BMS. 38	2.31	3.46			
BMP. 3295	—	3.23			
BMP. 4241	0.52	5.69			

1. From the British Museum (Natural History): P. 4232 and P. 4241 from Wenlock Limestone, Dudley, Worcestershire; S. 3772 and S. 3786 from Ludlow series, Aymestry Limestone, Ledbury, Herefordshire; P. 7051 (two specimens) from Lower Ludlow series, near Stokesay, Ludlow district, Shropshire; P. 3295 from Lower Ludlow series, Church Hill, Leintwardine, Herefordshire; and S. 38 from Lower Ludlow series, Shelderton, W. of Ludlow, Shropshire.

2. From the Geological Survey and Museum in London: Cast of GSM 6551 from Lower Ludlow, Ludlow.

Description.—

THALLUS: The shape of the thallus varies, the original specimens of Murchison are mostly oval (figs. 1, 2), other fossils are discoidal

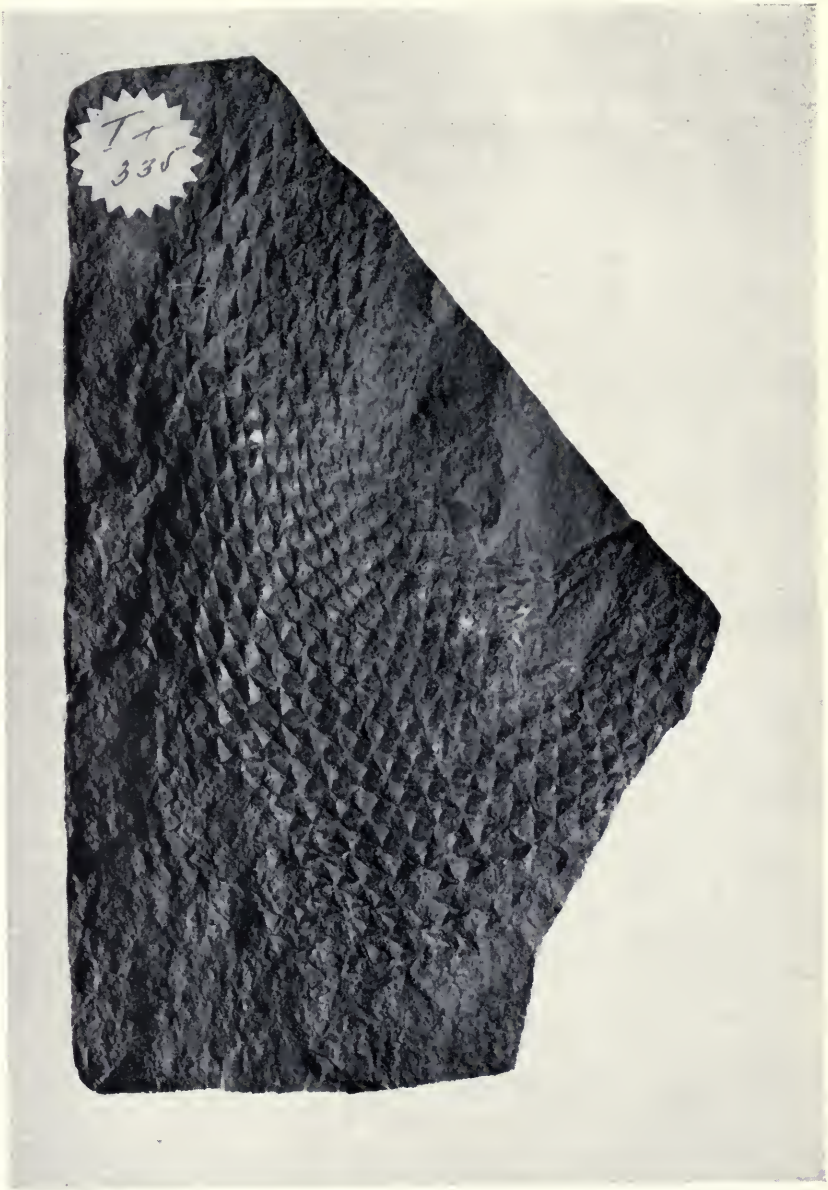

FIG. 6. Apical (?) view of *I. koenigii*, S. 3786. The impressions of stellate structures are within facets. × 1.3.

FIG. 7. Enlargement of the surface of *I. koenigii*, S. 3786 shown in Figure 6, showing relation of stellate structure to facets. × 2.8.

(figs. 3–5) and globular shapes are present (not illustrated). However, a great deal of post-depositional flattening is observed.

MAIN AXIS: Main axis is not observed in English specimens. The flattening of thalli and the shortness of the calcified laterals indicate that the main axis was relatively inflated and weak. The presence of the main axis is assumed for *koenigii* although it cannot be demonstrated.

LATERALS: Laterals are preserved in only one specimen (fig. 4) as cross-sections of small vacuities filled with calcite. Here they form horizontal and vertical lines that correspond to the arrangements of facets and stellate structures upon the surface. Not all laterals are cut at right angles to their axes, and therefore from the shape of the cut their directions can be extrapolated when the assumption is made that the laterals were circular in cross-section. They thus generally point toward the center of the thallus. Only the upper laterals are thus preserved, and no laterals are found in the lower, older portion of the thallus. This indicates that the bottom branches did not cal-

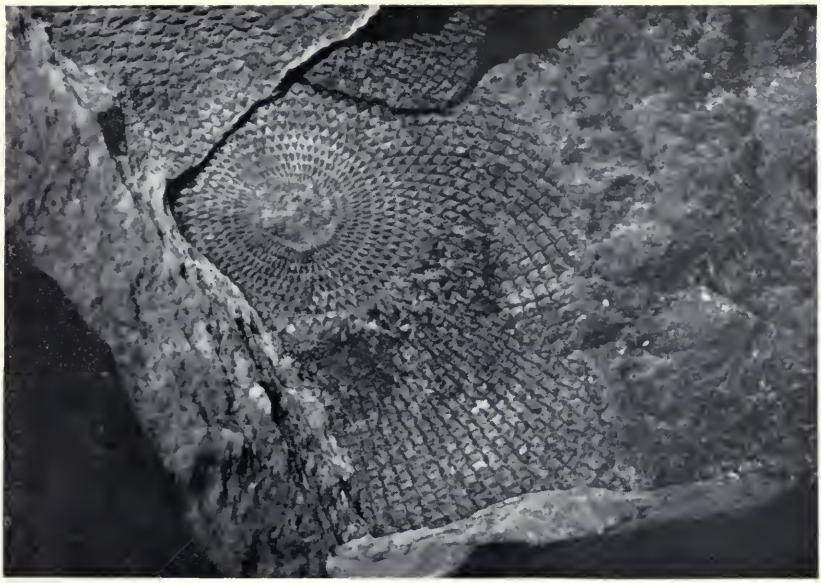

FIG. 8. Apical view of *I. koenigii*, P. 4241 showing the spiral growth lines, calcified facets, and stellate structures. × 3.3.

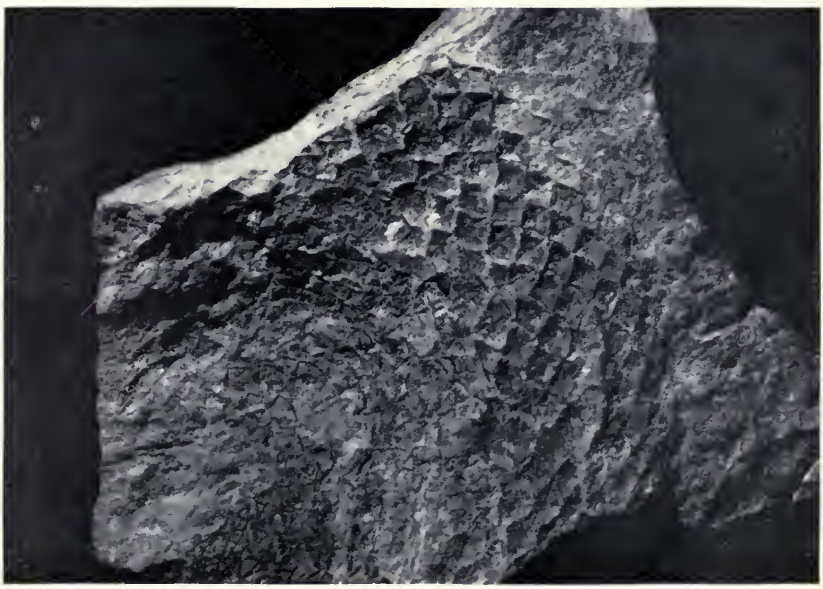

FIG. 9. The basal facets of specimen shown in Figure 8. The larger facets are closer to "equatorial" region. Detached stellate structures are observed. × 3.

FIG. 10. The apical (?) view of *I. koenigii*, P. 7051, showing the impression of facets and stellate structures. × 1.4.

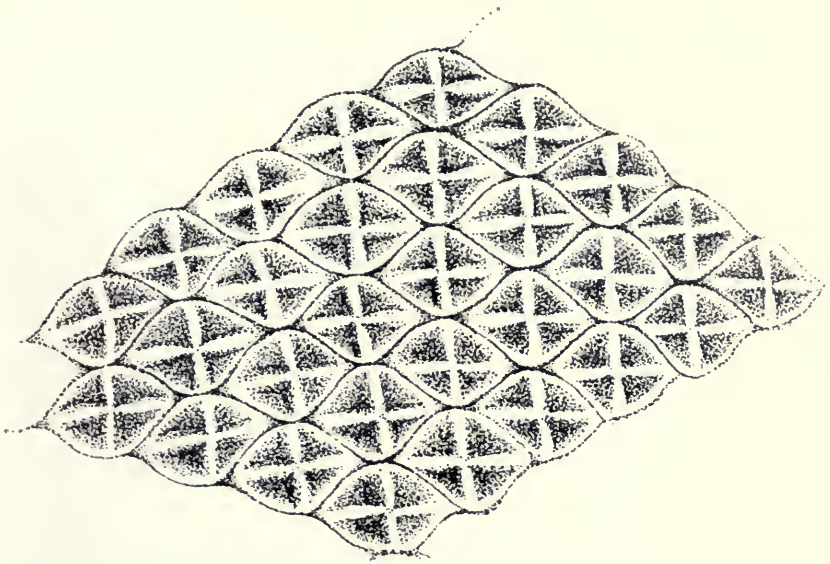

FIG. 11. Diagrammatic representation of stellate structures within facets. Based on P. 4232.

cify or were decalcified with age; the latter interpretation is preferred. Laterals are thus visualized as thin and weakly calcified. The calcification of lateral increases rapidly together with increasing thickness and terminates with lateral head. The laterals are borne in whorls.

STELLATE STRUCTURES: Stellate structures consist of four ribs arranged in a cross (figs. 6–11), in which two opposite arms lie above the other two, and thus form two sets of lines at right angles to each other. Each rib is generally expanding outwardly but sometimes ends in a point. The ends of ribs often touch the adjoining ribs, or may lie side by side. The stellate structures when misplaced are held together firmly indicating rigidity. The vertical ribs are distal and after removal of heads are seen first; the horizontal ribs are proximal, are below the vertical ribs and are abraded last. The ribs are often close together in the lower part of thallus (fig. 11) but commonly are also compressed by sedimentary compaction. In such cases the crosses of stellate structures form. The compression varies among individuals; in the holotype block the stellate structures are very compact and consequently the crosses are well preserved (fig. 1). In flattened specimens stellate structures are always compressed (figs. 6–7). The spacing between each set of ribs appears to fluctuate even on single

individuals and often seems diagenetic. The stellate structures probably add rigidity to the skeleton; the best preserved are at the lower ends of the thallus, where laterals are not calcified. In certain other

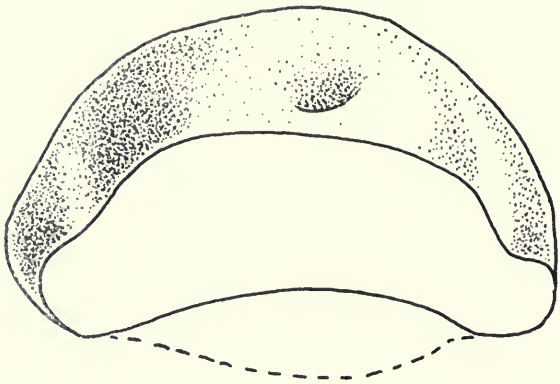

FIG. 12. Diagrammatic representation of shape of thallus based on P. 4232.

species of *Ischadites* where main axes and laterals are well calcified the stellate structures are often calcified to a much lesser degree.

FACETS: Facets are formed by the elevated walls of lateral heads that are packed together and compressed into rhomboidal figures. Although the calcification of lateral head is relatively strong, it is seldom preserved. Lateral head detaches easily, and commonly only facets remain. When the calcified portions of heads are preserved they are plate-like structures in contact with each other forming characteristic sinusoidal lines. These lines are also formed by the preserved elevated ridges left after the removal of calcified parts. Facets are now rectangular four-sided structures with sides somewhat rounded (fig. 7).

ATTACHMENT: No actual attachment is observed. The thallus of elongate specimens is broader in the lower part and is flattish in discoidal forms. This indicates that these fossils were either basally attached or were just resting upon the surface. If present, the attachment pedicle was probably very short. If these fossils were not attached, then they were simply sitting on the bottom in a cyclocrinitid habit.

CALCIFICATION: *I. koenigii* possesses a calcified outer wall that consists of calcified lateral heads and calcified stellate structures. It is these that give rigidity to the thallus. The stellate structures and

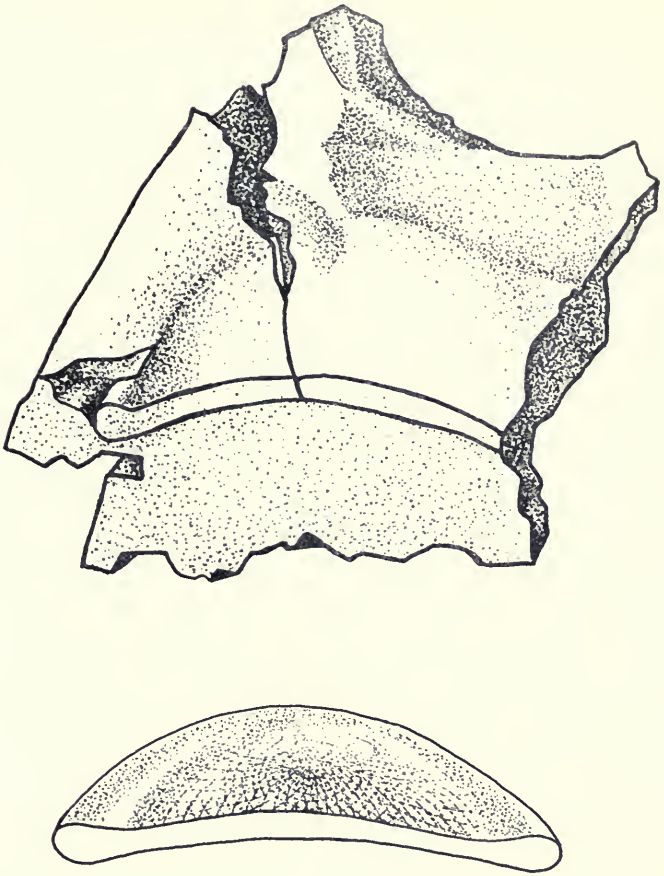

FIG. 13. Diagrammatic illustration of flattening of thallus based on P. 4241. The entire specimen is represented in the upper figure; in the lower the alga is taken out of the matrix.

facets form a lacework on the exterior. The facets and the distal ends of upper laterals are weakly calcified. The proximal ends of upper laterals and the entire lower branches are not observed. The base of the thallus appears uncalcified. Because the lower stellate structures are calcified but not the lower laterals it is assumed that the basal laterals decalcified as the organism grew. The very top of the thallus composed of the youngest laterals is likewise very weakly calcified or not calcified at all.

PRESERVATION: The preservation of these fossils varies from locality to locality. Thus, well-preserved specimens are found (figs. 3,

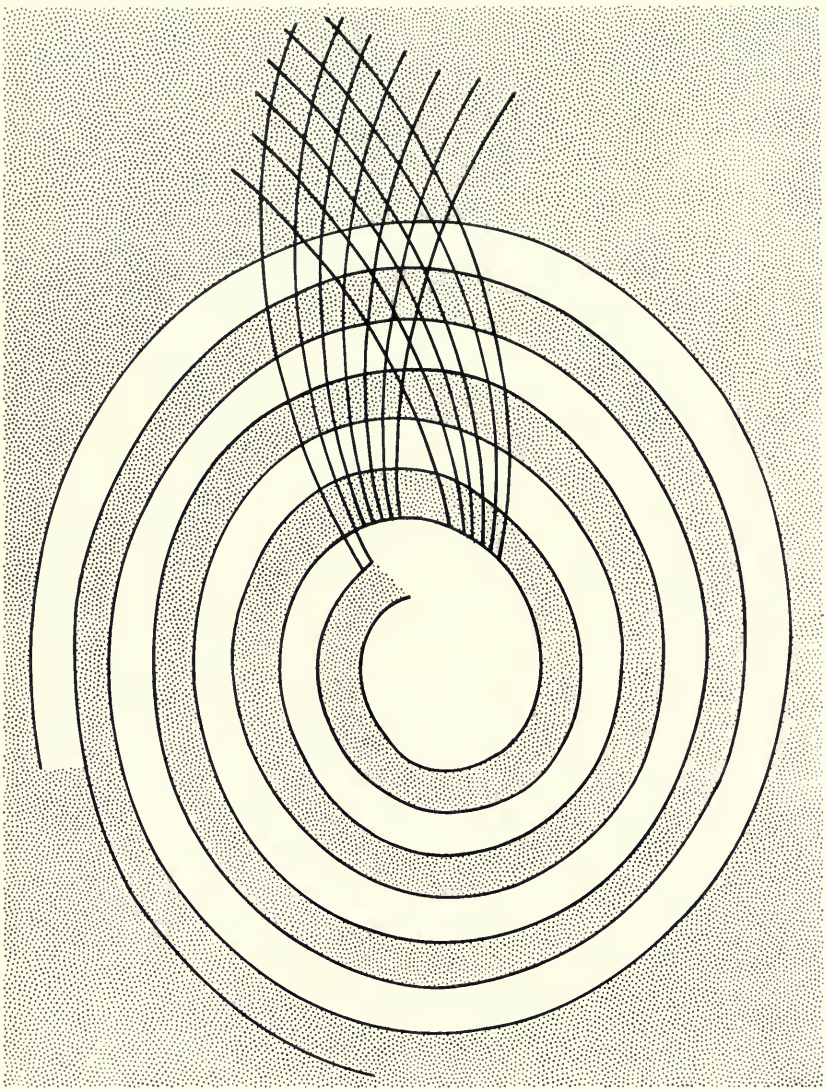

FIG. 14. Diagrammatic representation of growth pattern of *I. koenigii* based on P. 4241. The white oval spiral represents the continuous arrangement of facets. The thin black lines are portions of lines formed by edges of facets.

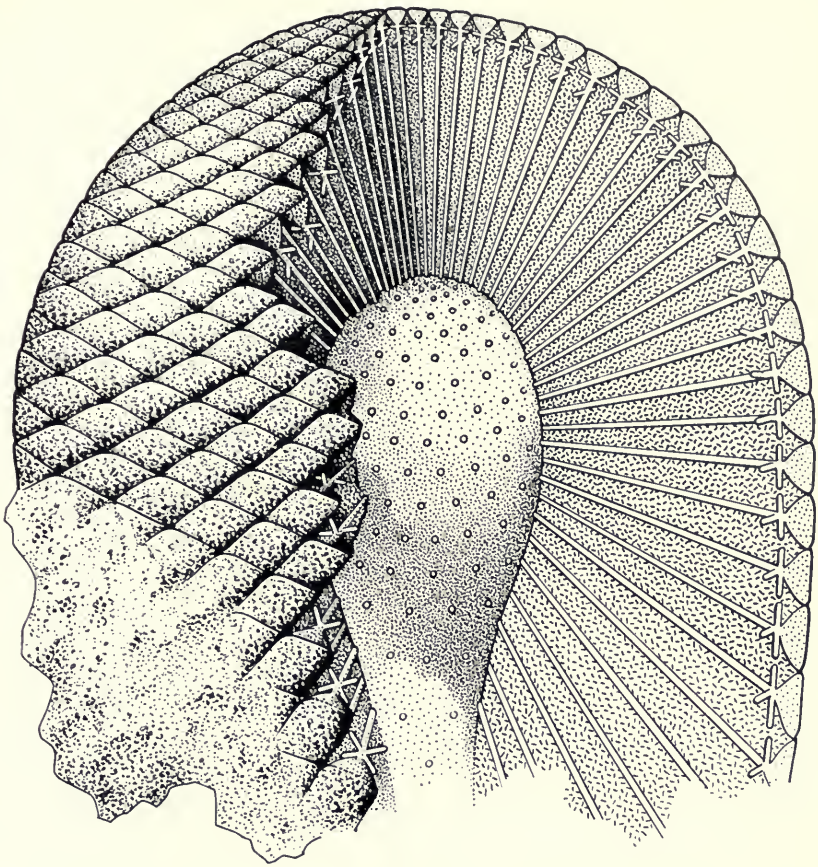

FIG. 15. Diagrammatic representation of *I. koenigii* based on the specimens from the Geological Survey and Museum in London and from the British Museum (Natural History).

4, 12) as well as fossils consisting of impressions only (figs. 6, 7, 10). This variation in preservation depends upon the matrix and the resulting different conditions of deposition. In limestone better-preserved thalli are found, but in shale only impressions are preserved. Flattening is observed in most specimens, however, the most extensive flattening is found in dark shaly matrix. One thallus is flattened in a form of a disc (fig. 13). The best preserved shape is found in the specimen P. 4232 (figs. 3, 4, 12) where the post-mortem compaction is very slight. In all specimens except in the type block the compaction, if present, is horizontal, and the specimens are flattened perpen-

dicularly to the position of the main axis. P. 4232 is now discoidal but compressive deformation is seen in its edge (figs. 4, 12). Certain fossils are preserved as flat impressions only (fig. 13). It seems that size had some control over flattening and the larger specimens seem more deformed than the smaller plants. Certain specimens (S.3772) acted as resistant bodies and slickensides formed upon their surfaces. The upper ends of most specimens are compressed indicating a weakness of skeleton at the apex.

GROWTH: A very well-preserved growth pattern is found on a number of specimens, and is best shown in Figure 14, where the very tip of the growth area is not preserved. However, the younger densely-packed laterals of the apex are forming a spiral. When viewed from above, this spiral appears levorotatory, and thus the growth direction in *koenigii* is upward along a helix and laterals are added spirally. The spiral is formed by close-packed arrangement of facets and ribs of stellate structures. These upper younger laterals are immature or sterile branches that are pushed down during growth and during spiral addition of new branches. The addition of laterals in other areas than at the growing top is also noted. There are considerably more laterals in the equatorial plane than there are at the apex. These new laterals are added at random, and no regular pattern of addition is detected. New laterals are represented upon the surface by the facets disrupting the regularity of existing spiral lines. Whenever such disruption occurs a new line follows behind the additional facet.

The growth of individual lateral heads increases further away from the top, as does the degree of calcification. The largest stellate structures are situated somewhat below the equatorial region. It seems safe to assume that below that region the growth did not occur.

RECONSTRUCTION: The reconstruction of the thallus of *I. koenigii* based upon the English material is shown in Figure 15.

ACKNOWLEDGMENT

It is a pleasure to thank Drs. A. W. A. Rushton of H. M. Geological Survey and Museum in London and H. W. Ball of the British Museum (Natural History) for loan of specimens and for helpful comments, and Bertram G. Woodland of Field Museum for reading the manuscript.

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