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BY

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MISSISSIPPIAN CUNEATE CORALS

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ABSTRACT—Cuneate corals are compressed parallel with the cardinal-counter plane. Species are known among three families and six genera or subgenera. Arguments are advanced that larvae oriented themselves with regard to current direction and that later curvature of the corallite depended upon current action. Cuneate corals were streamlined and therefore were successfully adapted for life in marine currents. *Triplophyllites* is divided into subgenera on the basis of direction of curvature. Species-groups are erected on the nature of flattening. The following species are revised: *Cyathaxonia venusta, Zaphrentis ulrichi, Z. acuta, Z. elliptica, Z. carinata, Z. clinatus, Z. capuliformis, Z. reversa, Z. compressa,* and *Z. lanceolata.* A new variety is named.

INTRODUCTION

THE great majority of Mississippian corals were formerly referred to "*Zaphrentis*" (misapplication and misspelling of *Zaphrenthis*). Any conical coral with simple morphology was thrown into this catch-all so that eventually the generic reference became meaningless. Groups of zaphrenthids subsequently were segregated into other or new genera, but there still remain some species assigned to this primitive generic concept.

Among the most difficult of paleontologic problems is the assignment of creatures whose hard parts contain relatively few morphologic features. The simple "zaphrenthids" have been neglected because they do not have enough characters to enable them to be identified as readily as can be many other corals. Corals reviewed in this study have, for the most part, only a compressed cup containing septa, a cardinal fossula, and tabulae. Differentiation of systematic categories among these corals rests upon the closer study of a few features, rather than upon emphasis of some outstanding morphologic specialization such as colonial habit, dissepiments, carinae, tabellae, lamellae, etc. Nevertheless, the simple "zaphrenthids" discussed below are distinctive in their own way and can be used confidently in stratigraphic work.

When fossils with simple morphology are described cursorily and figured indifferently, the difficulties attendant upon their identification are increased disproportionately. Not only do these factors concern the present corals, but in addition there has been a bland disregard of prior studies on part of some systematists. Finally, the corals treated herein are variable and hence are conducive toward frustrating field applications of paleontology to stratigraphy.

METHODS OF STUDY

Having successfully avoided becoming involved with the simple "zaphrenthids" for some time, the writer was brought up against the problem again by seeing a simple compressed "zaphrenthid" from the collection of Dr. Alexander Stoyanow. A search of the literature revealed several species but their relationships were obscure and their distribution questionable. The writer therefore resolved to restudy the species concerned.

Through the financial assistance of the University of Southern California, the writer was enabled to visit several museums where pertinent material is available. All known types and comparative materials were located and studied in detail. In addition, considerable field work was done in Indiana and Kentucky to ascertain the exact occurrence of these fossils in place. Many of the type localities have been visited by the writer either as mentioned above or during previous years.

Inasmuch as these simple corals do not contain important morphologic features hidden within their inner recesses, it was not necessary to conduct extensive thin section studies. Early stages usually could be observed in immature specimens rather than by making sections.

STRATIGRAPHY

The pertinent areas of outcrop are along the Mississippi River in Iowa and Missouri and thence about 300 miles to the east across the Eastern Interior Basin in central and southern Indiana.

In Fig. 1(p. 382) the average thicknesses of the formations are given. Lithologies are those of each area of outcrop, not of any particular section. One is impressed with the increasing shaliness of the Warsaw southward in Indiana. Moreover, the Salem limestone thins into Kentucky and may be locally absent there. Subsurface studies demonstrate that Burlington-Keokuk limestones along the Mississippi River grade very abruptly into shales in western Illinois (Payne, 1940, p. 232, fig. 3); where these strata reappear as outcrops in Indiana, the calcareous facies of the Burlington-Keokuk is still missing and the silty shales are known as the Borden group.

ECOLOGY

Although the Burlington-Keokuk limestones are quite fossiliferous in the region of their type sections, the beds of the same age in Indiana and Kentucky are sparsely fossiliferous. The difference is related to the change from calcareous to shaly environment. Only where the Borden group becomes locally calcareous (as at the famous Button Mould locality near Louisville, Kentucky, or at the equally renowned crinoid bioherms at Crawfordsville and Lobo, Indiana) can one collect many fossils. For this reason, the parallel development of corals in the Indiana-Kentucky region and in the Iowa-Missouri region has not been substantiated for those species of pre-Meramecian age.

Similar ecologic conditions apply to the progressive increase in shaliness of the Warsaw and Salem limestones southward in Indiana. Corals are commonest in the calcareous facies and are rare or absent elsewhere. Some very notable examples of the preference of the rugose corals for a limy environment can be studied in alternating shale and limestone sequences in Indiana. At locality 7, for instance, the Borden-Harrodsburg contact consists of a transitional alternating series of shales and limestones. Corals are nearly confined to the limestones.

ACKNOWLEDGEMENTS

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MORPHOLOGICAL MODIFICATIONS

Compressed corals have long been known, but only one type of compression has been discussed in any detail. Grove (1935, pp. 355–358) recognized the flattening of the cardinal or of the counter side of several species of rugose corals and named these "calceolid" corals in allusion to their having the shape of a slipper. One of these calceolid corals, *Lophophyllum calceola* White and Whitfield, in 1862, occurs in Mississippian strata. It is the type of the subgenus *Hapsiphyllites* Easton, 1944, hereinafter emended.

The corals restudied here are compressed, but the compression involves the alar sides of the corallite, that is, it is bilateral and parallel to the cardinal-counter plane. In comparison, it is arranged at right angles to that in the calceolid corals. Inasmuch as the resulting shape is that of a wedge, the English word "cuneate" is proposed (from

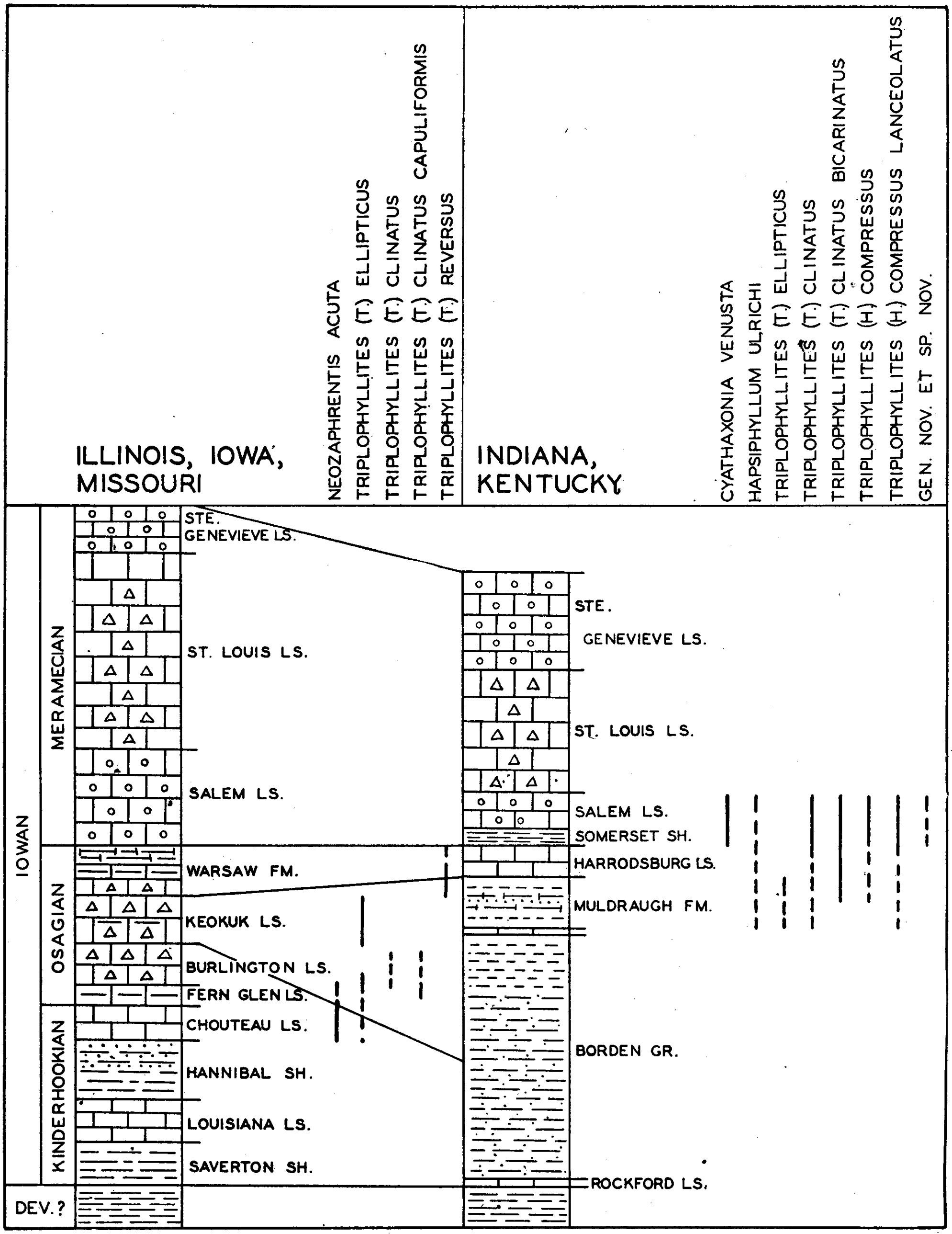


FIG. *1*—Composite columnar sections of strata within the Iowan series of Illinois-Iowa-Missouri and Indiana-Kentucky. The stratigraphic range of each species is shown by vertical lines to the right of the appropriate columnar sections. Correlation lines between sections are not intended to affect the vertical ranges of species.

the Latin cuneus, wedge) as a term descriptive of this morphological modification.

As among the calceolid corals, the cuneate corals belong to several different groups: in this case being *Cyathaxonia*, *Homalophyllites*, *Hapsiphyllum*, *Neozaphrentis*, *Triplophyllites*, and an unnamed new genus. The cyathaxonid corals and the zaphrenthid corals have somewhat different modes of septal insertion and therefore are quite distantly related. Among corals with a zaphrenthid type of septal insertion *Hapsiphyllum*, *Homalophyllites*, *Neozaphrentis*, and *Triplophyllites* still are not closely related, for the first genus has contratingent minor septa and the other three have straight minor septa. It follows then that the cuneate shape is present among three coralline groups of diverse initial relationship.

EVOLUTION

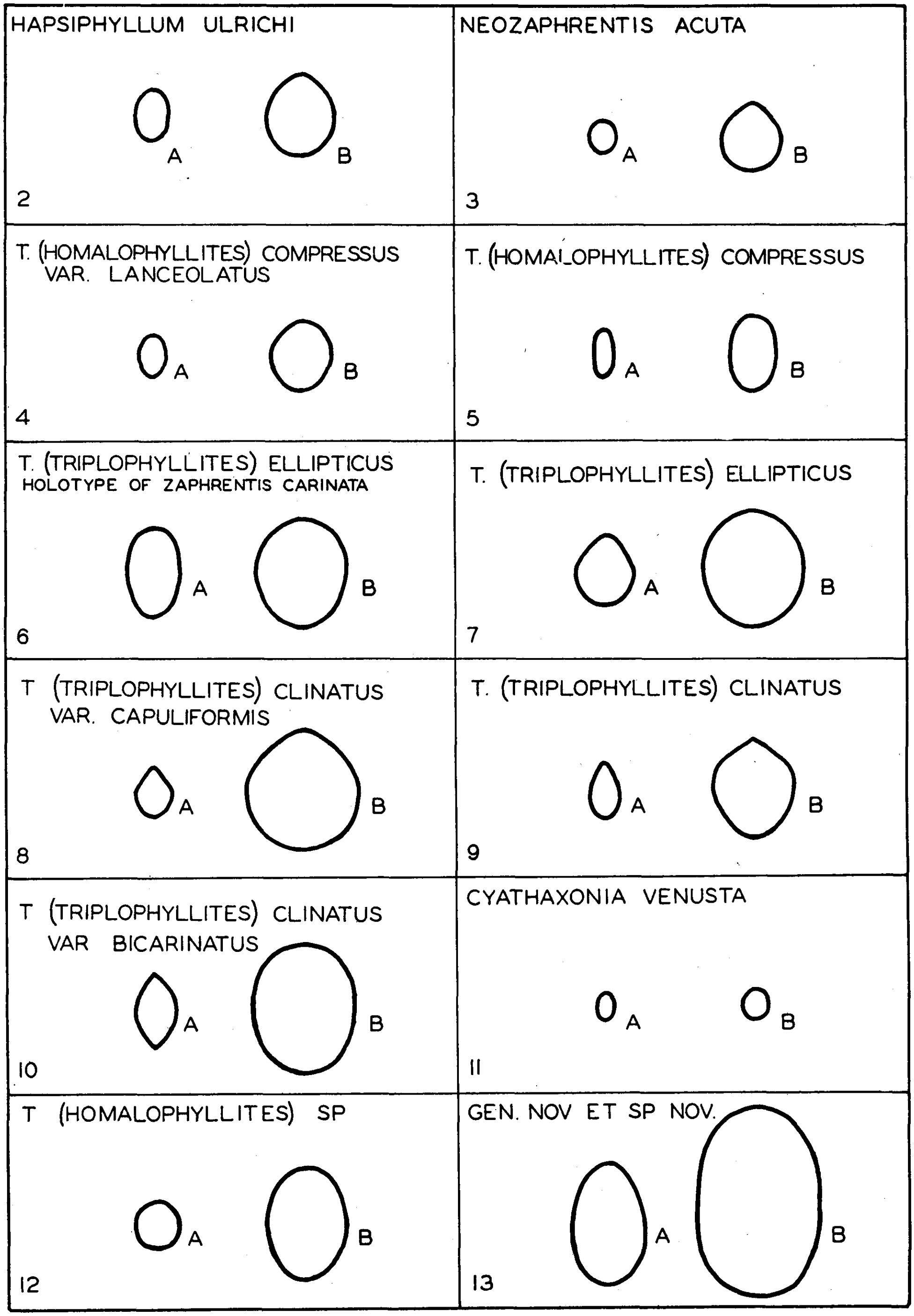
In the genera containing cuneate corals a similar developmental relationship exists. In earlier (or sometimes in contemporaneous) strata perfectly normal species belonging to a particular genus occur. That is, the zaphrenthid or cyathaxonid genera contain the features characteristic of the genotype. At some subsequent time (or as a result of apparent radiation) one or more morphologic features of less than generic rank are introduced. Some corals may become reoriented so that the cardinal fossula is on the convex side. Some corals become cuneate and either have the dominant or reoriented fossular position. Other corals become calceolid. From a stratigraphic point of view it is curious that the cuneate shape reaches its acme at about the same time in different genetic strains. From a biologic point of view it is curious that the particular strains which are cuneate or calceolid become so just before their disappearance from the geologic record.

It is quite apparent that there is only remote genetic relation between the various groups. The cuneate shape, therefore, must arise either because of orthogenetic tendency or by selective adaptation to environment. The corals discussed herein can be used to erect an argument for orthogenesis more far-reaching than that constructed on the basis of titanothere evolution, because the relationships are more diverse taxonomically among these particular anthozoans. By the same token, the arguments against such an interpretation are equally as forceful as those concerning titanothere evolution, and perhaps more so, for the corals are so simple that one can not be absolutely certain whether he is dealing with genetic strains or with parallel development. No entirely satisfactory method is known to the writer whereby a cuneate corallite will ensue from normal ancestors. No difficulty is encountered in explaining how a calceolid coral arises—as a matter of fact, two methods are known. In the first instance the calceolid coral may be equipped with an operculum which requires a straight side for hingement. In the second instance the corals may become flattened as an accommodation to bottom-dwelling habit, the corallite becoming flattened in recumbent species.

The cuneate corals are not known to have been operculate. Moreover, with two flattened sides it is hard to imagine one operculum having two hinge lines, but of course one can say that these forms had two opercula, each with its own hingement, but that they were not preserved or have never been found. In these cases nothing is gained in the way of intelligence.

Likewise, it is difficult to see how the flattening could be influenced by growth habit as in calceolids, for the corallites are flattened on two opposing sides. It hardly seems reasonable to conclude that they shifted their recumbent position from side to side.

About the only clue as to what function the keeled shape served lies in the sedimentary record of the region. During early Iowan time the seas covering the central states were moderately shallow and currents were not very strong. The limestones tend to be dense and crystalline and to occur in massive strata. By later Iowan time—specifically, at the beginning of the deposition of the Warsaw formation—the currents became stronger, presumably in accordance with a slight shallowing of the seas. Impure, thin-bedded, shaly limestones tend to be the dominant type of Warsaw sediment, but these grade laterally into granular limestones which may be oolitic. Above the



FIGS. *2–13*—Cross-sections of cuneate corals. In each pair, *a* is taken one-third of the distance from the calyx and *b* is at the calyx. All figures except *4*, *12*, *13* are of the holotypes, 1×.

Warsaw the succeeding limestones of the Iowan series are commonly oolitic and cross-bedded and are in large part shallow water deposits. It is in these sediments that the cuneate shape is best developed.

Two features concern explanation of the development of cuneate shape. These are the response to current-dwelling and the obtaining of food. Perhaps the elliptical shape was an adaptation to reduce resistance of the corals to the currents. At least the resistance would be less if the corals grew oriented with their long transverse dimensions in line with the currents. No instance is known in which a population of cuneate corals has been observed with the creatures erectly disposed, so there is not direct evidence as to how they might have been orientated on the sea floor.

The other feature is based upon observations made by Jones (1907, p. 529), who studied growth-forms of recent colonial corals in the Cocos-Keeling Islands. He reports that "vertical plates grow so that they offer their flat surfaces to the currents. The same thing is true of growths that are branching forms, for then the plane of greatest branching is that at right angles to the line of current." Jones assigned the cause of this orientation to the fact that the currents transported the food for the polyps and that the growth was directed so as to offer the most advantageous position for food-gathering.

The great majority of simple rugose corals are curved. Usually the curvature is consistently in one direction among the individuals of any one species. Moreover, most species are curved in the direction of the cardinal fossula (or it is said that the cardinal fossula is on the concave side). Very few corals are consistently erect in the form of right cones, although this may have been the archetypal habit. It would seem then, that there is a dominant tendency of ancient origin for corals to curve. The fact that the curvature is relatively constant within a species would indicate that when each larva established itself upon the substratum, it orientated itself in some characteristic position with regard to prevailing currents. Failure to do so would cause aberrant curvature of the corallite subsequently. Haphazard orientation, which seems to have existed in some species, would result in all manner of curvature with respect to location of the cardinal position. From these considerations the writer concludes that the orientation of the larva with respect to currents is probably governed by a genetic factor, whereas the curvature itself is probably due to an environmental factor. In this way it is possible to explain biologically how members of a coral species that consistently curve in one direction occasionally show aberrant curvature. This defection could arise if the larva failed to become properly oriented with respect to prevailing currents and then developed a curvature toward the food-transporting currents after the protothecae were secreted. If the tendency toward curvature in some particular direction were a genetic feature, then the aberrant curvature is harder to explain. One is reminded of the vexatious problems concerning the nature and importance of spiralling in dextral and sinistral gastropods. Sometimes it is of a genetic nature and is of apparent taxonomic value and other times it is probably due to embryologic accident.

In review, it is interesting to note that the curving of a coral so as to present the polyp's greatest surface to the currents would be in the same plane that the flattening of the cuneate corals occurs. Probably the cuneate shape is a late modification causing improvement in streamlining of the corallites whose orientation and tendency toward curvature are of early standing. Cuneate shape seems to be of a genetic nature within any species, for this feature is always developed in the same way, regardless of aberrations in curvature.

Currents were not peculiar to post-Iowan seas. Low velocity currents are known even in abyssal waters, so light currents obviously ran in the epeiric seas of Lower Mississippian time in the Midwest. In post-Iowan time, however, the currents seem to have increased in velocity. The culmination of the cuneate shape coincides with the presence of strong currents.

SYSTEMATIC PROBLEMS

Several species of corals which resemble each other in general appearance possess dissimilar internal morphology. Genetic

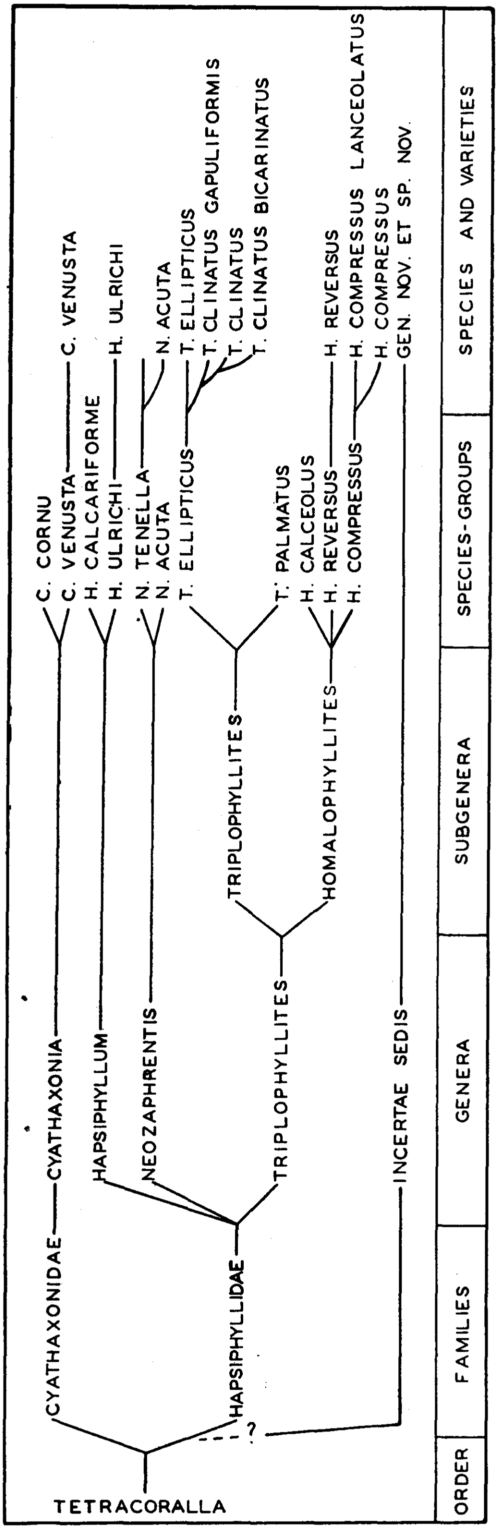


FIG. 14—Taxonomic categories and phylogeny used in this paper.

relationship is presumed to be manifest when coral species contain the same morphologic features but in different degrees of development. Accordingly, the corals considered below can be divided into four genetic groups, all of which contain thecae, septa, tabulae, and some indication of a cardinal fossula, but which individually may be characterized as follows:

Cyathaxonia.—Has "cyathaxonid" order of septal insertion and a columella.

Triplophyllites.—Has "zaphrenthid" order of septal insertion and usually has dissepiments at some stage in development. Usually is conical, rather than being cylindrical or flaring.

Neozaphrentis.—Has "zaphrenthid" order of septal insertion and cardinal fossula bounded by unfused inner edges of septa.

Hapsiphyllum.—Has "zaphrenthid" order of septal insertion, contratingent minor septa and lacks dissepiments.

The only reason that it becomes necessary to consider these genera together is that the shapes of the individuals of some species are unique and the same in each group. The species of different or even similar genera would possibly be considered to be conspecific if only external features were observed. Likewise, different species within a genus may resemble each other in their curious shape, yet be otherwise specifically separable. The first of these conditions (similar but unrelated species) is commonly termed isomorphism. The latter condition (similar related species) is commonly called homoeomorphism. Inasmuch as both conditions are found among cuneate and calceolid corals, the first problem to be settled involves distinguishing between isomorphs and homoeomorphs. Otherwise, any proposed classification would be deficient.

Simple corals are most commonly in the shape of a curved cone with a circular cross-section throughout. Cuneate or calceolid corals usually tend toward a "normal" cross-section at some stage in their ontogeny and hence are considered to be modifications of the original round stock. Among the simply organized creatures considered herein, the cuneate or calceolid modification is the principal feature by means of which isomorphism or homoeomorphism is manifested. Therefore, these modifications of existing structure are given a subordinate position in the systematic arrangement of the species. Major modifications are considered to be of specific value, whereas minor modifications of these in turn are considered to be of varietal magnitude.

The second problem concerns the systematic importance to be attached to curvature of the coral. Four orientations are known: (*a*) the cardinal fossula is on the concave side when the corallite is viewed from either alar side; (*b*) the cardinal fossula is on the convex side with similar orientation; (*c*) the cardinal fossula is variably located; (*d*) the corallite is a right cone, that is, it is not curved, and hence, the cardinal fossula is not demonstrably on one side or another.

Case *d* is rarely encountered. Case *c* is known but is not common. It is, however, common among groups of specimens of *Zaphrentis calcariformis* Hall, 1882. In a large number of specimens one finds that more than half of them have the cardinal fossula on the concave side. Among the other specimens, some will be contorted so that the position of the fossula varies in one specimen. Some will be contorted or straight and the fossula will be in some position of greatest concavity. Others will, more rarely, have the fossula somewhere on the convex half of the coral. Lastly, some specimens may have elongate scars of attachment in the apical portions of the corallites and then may be curved or contorted distally; in both these latter instances, the trace of the cardinal septum usually lies along the greatest diameter of the scar of attachment. In the majority of all foregoing conditions, the cardinal fossula is somewhere on the concave side, even though it may not be at the place of greatest concavity.

Even though some variation in the location of the cardinal fossula with respect to curvature is established, the writer still considers the character to be of taxonomic value. After all, its variable location is merely a manifestation of the natural tendency of organisms to vary. It would seem, then, that *Z. calcariformis* Hall is merely a species from which one could expect a new strain of corals to evolve, with the cardinal fossula located on other than the concave side. Viewed in this fashion, the species becomes additionally significant from an evolutionary standpoint.

It is a well-known fact that the counter quadrants of rugose corals usually contain more major septa than do the cardinal quadrants. Inasmuch as the rugose corals are commonly curved toward the cardinal septum, it naturally follows that the counter quadrants are potentially expanded (as if they were stretched around the calyx rim) by the greater curvature on that side. Additional septa occur in the counter quadrants in the expanded regions, but it is not known whether the expansion necessitates their insertion or vice versa. On the other hand, it can be observed among the corals studied herein that the counter quadrants are consistently accelerated no matter on which side the cardinal fossula lies. This runs counter to the principle observed among rugose corals in general (which mostly have their cardinal fossulae on the concave side). If the coral is convex on the cardinal side, one would assume before observing the septa that they would not be accelerated on the counter side, or even that they might be accelerated on the cardinal side. It is concluded, then, that as a general rule, the distribution of septa within the quadrants of a calyx results from a strong genetic requirement. Moreover, deviations from the normal situation are usually minor in effect. If these conclusions are valid, then one may further conclude that the distribution of septa within a calyx has been determined by long established genetic lines. In other words, the distribution of septa will tend to remain constant for a time even though the shape of the coral may begin to change. From these matters, the writer has concluded that the orientation of the cardinal fossula with regard to curvature is less important taxonomically than is the nature and degree of acceleration of the septa. Accordingly, the location of the cardinal fossula is assigned subgeneric status.

The third problem is to arrange the various corals into such taxonomic groups that their inter-relationship is apparent, yet assuring that the cuneate (or round, or calceolid) corals of one genus or subgenus may be distinguished by a collective term from the cuneate (or round, or calceolid) corals of another higher category. The term "circulus" has been proposed (Gregory, 1896, p. 22) as a systematic group, the members of which bear the same relation to some standard species as did the rings of listeners to each of several speakers in a Roman forum. This original usage implies lack of genetic relationship and also a rather haphazard but necessary collection. It is essentially a term to include isomorphic species. It could be used to designate all cuneate, all calceolid, or all conical corals. Circulus has been used in other senses, however, and would possibly be suitable under one of these latter, but not under its original meaning.

Vaughan (1905, p. 183) proposed "gens" for "the aggregate of all the species which possess, in common, a large number of essential properties, and are continuously related either in space or time."

It is not possible to say that the corals under discussion contain a large number of properties in common for their structure is quite simple. Yet their structure is ample enough for careful differentiation. Possibly distinctive groups of these corals could be alluded to as gentes.

On the other hand, the straight-forward appellation "species group" conveys just what is desired. Groups of species which differ collectively from other similar groups, yet whose similarities are not of generic or subgeneric rank, may conveniently be encompassed in species-groups.

SYSTEMATICS

Investigation of the following corals has revealed morphologic features not hitherto known. Philosophical consideration of relationships results in rearrangement of some genera and species previously studied by the writer. Whenever systematic reorganization is required, the writer puts forth the background and reasons for these changes.

In the following section, AMNH refers to the American Museum of Natural History. IGS refers to Illinois State Geological Survey. UA, to the University of Arizona. USC, to the University of Southern California. UI, to the University of Illinois. UM, to the University of Michigan. USNM, to the U. S. National Museum.

Phylum COELENTERATA
Class ANTHOZOA
Order TETRACORALLA
Family CYATHAXONIDAE Milne-Edwards & Haime, 1850
Genus CYATHAXONIA Michelin, 1847

Cyathaxonia cornu species-group

Diagnosis.—*Cyathaxonia* with the cardinal fossula on the concave side of the corallite and with a conical shape.

Remarks.—Most species of *Cyathaxonia* belong here.

Cyathaxonia venusta species-group

Diagnosis.—*Cyathaxonia* with the cardinal fossula on the convex side of the corallite and with a cuneate shape.

CYATHAXONIA VENUSTA Greene, 1904
Plate 61, figures 10–14; text-figure 11

1879. not *Cyathaxonia compressa* THOMPSON, Proc. Phil. Soc. Glasgow, vol. 11, no. 18, p. 197, pl. 1, fig. 6.
1899. *Cyathaxonia compressa* GREENE, Contributions to Indiana Palaeontology, pt. 2, p. 9, pl. 4, figs. 14–17.
1904. *Cyathaxonia venusta* GREENE, Contributions to Indiana Paleontology, pt. 19, p. 187, pl. 56, figs. 10–14.
1906. *Cyathaxonia venusta*. BEEDE in Beede and Cumings, Indiana Dept. Geol. Nat. Res., 30th Ann. Rept., p. 1202, pl. 11, figs. 2, 2a.
1906. *Cyathaxonia venustum*. BEEDE in Beede and Cumings, Indiana Dept. Geol. Nat. Res., 30th Ann. Rept., p. 1373.
1922. *Cyathaxonia venustum*. CUMINGS, Handbook of Indiana Geology: Indiana Dept. Cons., Pub. 21, pt. 4, p. 505.

Description of Holotype.—Corallite an elliptical cone slightly curved away from the cardinal fossula. Cross-section lanceolate near the apex and ovate near the calyx. Surface smooth except for faint traces of septa due to weathering. Theca rather thick.

Calyx shallow, 2.5 mm. deep. Septa in two orders, totaling 32. Cardinal fossula nearly parallel-sided, deep, slightly wider than other loculi. Cardinal septum extends one-third length of fossula in calyx. Counter septum similar to the other major septa but joined near its axial end by the minor septum on either side. On each side of the calyx are seven major septa which join the columella. They are a little thicker near the theca than along most of their length.

Alternating with these is an equal number of minor septa which do not extend as far distally as the majors and which lean in the counter direction to fuse with the majors just before reaching the columella. The minors are very thin most of their length but are as thick as majors near the theca. At the calyx rim major and minor septa are the same length. Columella smooth, slightly oval near the calyx floor, about 2.0 mm. high.

Dimensions.—Height 15 mm. Greatest diameter of calyx 5 mm. Least diameter of calyx 4 mm.

Description of Paratypes and Hypotypes.—The paratypes all have 32 septa also and are arranged as in the holotype. In one of the paratypes the cardinal septum is perfectly preserved and its upper edge can be seen to slope steeply into the fossula and then swing over to the columella. There is some small variation in the length of the counter septum. In some calices it is slightly longer and in others, slightly shorter than are the neighboring majors.

Greene's hypotypes are like the holotype except that they are a little more narrowly elliptical and two of them have 34 septa.

Material.—Specimens studied: nine. Holotype: AMNH Nos. 23413–23415. Greene's hypotypes: AMNH Nos. 24045–24049.

Type locality.—Greene gave the type locality as "Warsaw division of the St. Louis group" at Georgetown and Lanesville, Indiana. In terms of recent geological usage, this probably means that the fossils came from the Salem limestone (Meramecian series of the Mississippian). One particular locality in the Salem limestone at Lanesville was and is a favorite collecting locality of many paleontologists. Inasmuch as Greene had all the syntypes together (and they are similarly preserved) one might assume that they came from one locality. The only places where this species has been collected by others than Greene is from the Salem limestone at Lanesville, Paynter's Hill, and Spergen Hill, so there is some reason to believe that Lanesville is the type locality.

Localities.—12, 13 (type locality).

Remarks.—The types are all reddish silicified replacements. The writer removed red clay from the loculi between septa when studying them. At Lanesville the Salem fauna is obtained by washing red residual clay to obtain the silicified fossils.

Family HAPSIPHYLLIDAE Grabau, 1928, emend. Easton, 1944

Genus HAPSIPHYLLUM Simpson, 1900

Diagnosis.—Simple tetracorals with long contratingent minor septa. Cardinal fossula long and slender. Alar pseudofossulae more or less distinct. Counter septum joined by adjacent minors to form a tripartite structure. Tabulae present. Dissepiments absent. Cardinal fossula usually on concave side of corallite.

Genotype.—*Zaphrentis calcariformis* Hall, 1882.

Remarks.—The writer (1944, p. 42) emended the genus *Hapsiphyllum* so as to include the subgenus *Homalophyllites* Easton, 1944. This procedure brought together corals with normal short minor septa and corals with longer contratingent minor septa. Since 1944 the writer has had occasion to study in new species many more specimens of corals with contratingent minor septa. It has been concluded that this feature is stable enough to warrant separation of the subgenera *Hapsiphyllum* and *Homalophyllites*. Therefore, the emendation proposed in 1944 is considered inapplicable. The effect of this action is to suppress *Hapsiphyllum* as a subgenus and to reassign the subgenus *Homalophyllites* to another genus. (For further remarks, see under *Triplophyllites*).

Hapsiphyllum contains two parallel series of corals, one with a normal conical shape, the other with a cuneate shape. These are the basis for recognizing two species-groups in the genus.

Hapsiphyllum calcariforme species-group

Diagnosis.—*Hapsiphyllum* with a conical shape.

Remarks.—Included here are *Hapsiphyllum calcariforme* (Hall), 1882 and *Hapsiphyllum cassedayi* (Milne-Edwards), 1860.

Hapsiphyllum ulrichi species-group

Diagnosis.—*Hapsiphyllum* with a cuneate shape.

HAPSIPHYLLUM ULRICHI (Worthen), 1890
Plate 60, figures 11a–c; text-figure 2

1889. *Zaphrentis ulrichi* MILLER, N. Amer. Geol. and Paleontology, p. 210 (nomen nudum).
1890. *Zaphrentis ulrichi* WORTHEN, Geol. Survey Illinois, vol. 8, p. 76, pl. 10, figs. 10, 10a.
1898. *Zaphrentis ulrichi* WELLER, U. S. Geol. Survey Bull. 153, p. 649.

Description of holotype.—Corallite an elliptical cone, curved in the direction of the cardinal position. Cross-section somewhat more narrowly elliptical near the apex than near the calyx. Depth of calyx not known. Cardinal fossula very deep, extending slightly past the center of the calyx, and broadest in its inner portion. Cardinal septum very short near the calyx but crossing the fossula farther down. Other septa of two types: the majors fuse at their inner ends to form the fossular wall; the minors lean toward the counter position and each fuses with the next adjacent major septum about one-third of the distance to the axis. The counter septum is fused with the next adjacent minor septum on either side about half of the distance to the axis. The right cardinal quadrant contains six pairs of septa; the right counter quadrant contains seven pairs; the left counter quadrant contains eight pairs; and the left cardinal quadrant contains five pairs. Thus, the calyx contains 28 major septa (counting the cardinal septum). Alar pseudofossulae are distinct because they extend farther axially than do the neighboring loculi.

Dimensions.—Holotype, height 20 mm. Greatest diameter of calyx 11.5 mm. Least diameter of calyx 10 mm.

Material.—Specimens studied: six. Holotype and paratype, IGS (Worthen Collection) No. 2573. Topotypes, USNM No. 42743.

Type locality.—Warsaw formation (Meramecian group, Mississippian system), Colesburg, Kentucky. (Coalsburg [sic] on label).

Remarks.—The Worthen collection contains four specimens bearing the number 2573. One of these specimens, which is of different preservation than the other three, is a species of *Triplophyllites.* It is so different from the other three that it is doubtful that Worthen included it among the original types. Possibly this specimen became associated with the type labels accidentally and was so numbered.

Of the other three specimens, one, which is the basis of Worthen's figures of the species (Worthen, 1890, pl. 10, figs. 10, 10a) is hereby designated the holotype. The dimensions of the figure agree with those of the "medium size individual" mentioned in Worthen's description. The actual measurements of the specimen differ slightly from the stated measurements. One concludes that Worthen's measurements were taken from the drawings, with which they agree.

The two remaining specimens are not at all well preserved. The smallest is not identifiable. The largest specimen probably belongs to *Hapsiphyllum ulrichi*, but it is not possible to decide even how many major septa it had. Even so, it becomes a paratype. Its calical diameters are 13 mm. by 14 mm.

The largest specimen seen (USNM lot 42743) measured 34 mm. in length, with calical diameters of 15 mm. by 13.5 mm. The usual number of septa is 26, but specimens with 28 and 29 have been studied.

Occurrence.—Localities 1 (type locality), 2.

Genus NEOZAPHRENTIS Grove, 1936

Remarks.—Since Grove erected *Neozaphrentis* upon *Zaphrentis tenella*, the species *Z. acuta*, *Z. palmeri*, and *Z. parasitica* have also been referred to the genus. Of these, *Z. acuta* shows a cuneate tendency, and so it is necessary to make two species groups in the interests of consistency.

Neozaphrentis tenella species-group

Diagnosis.—*Neozaphrentis* with a circular cross section.

Neozaphrentis acuta species-group

Diagnosis.—*Neozaphrentis* with a cuneate shape.

Remarks.—*Neozaphrentis acuta* is not consistently cuneate, but it still is reasonable to establish this species group. It is probable that *N. acuta* is very close to the point of separation of the two species-groups and that the cuneate tendency is not well established in the species because only a small evolutionary period elapsed since the tendency originated.

NEOZAPHRENTIS ACUTA (White & Whitfield) 1862

Plate 61, figures 6, 7; text-figure 3

1862. *Zaphrentis acutus* WHITE & WHITFIELD, Proc. Boston Soc. Nat. Hist., vol. 8, p. 306.
1865. not *Zaphrentis acutus*? WINCHELL, Acad. Nat. Sci. Philadelphia Proc., p. 111.
1883. *Z.* [*aphrentis*] *acuta*. WHITE, U. S. Geol. Geog. Survey Terr., 12th Ann. Rept. (1878), p. 159. (Advance printing, 1880).
1889. *Zaphrentis acuta*. MILLER, N. Amer. Geol. and Paleontology, p. 208.
1894. not *Zaphrentis acuta*. KEYES, Missouri Geol. Survey, vol. 4, p. 109, pl. 13, fig. 4.
1897. not *Zaphrentis acuta*. KEYES & ROWLEY, Iowa Acad. Sci., vol. 4, p. 30.
1898. *Zaphrentis acuta*. WELLER, U. S. Geol. Survey Bull. 153, p. 644.
1908. not *Zaphrentis acuta?* ROWLEY, Missouri Bur. Mines, ser. 2, vol. 8, pp. 31, 62, 63; pl. 16, figs. 19, 20.
1908. not *Zaphrentis acute* [sic]? ROWLEY, Missouri Bur. Mines, ser. 2, vol. 8, p. 33.
1908. not *Zaphrentic* [sic] *acuta*. ROWLEY, Missouri Bur. Mines, ser. 2, vol. 8, p. 62.
1943. *Neozaphrentis*? *acuta*. WILLIAMS, U. S. Geol. Survey Prof. Paper 203, p. 56 (not pl. 6, figs. 31–33).

Description.—Simple corallites in the form of curved cones, rarely cuneate. Epitheca smooth, with encircling swellings. Calyx oblique, sloping down toward the concave side. Cardinal fossula very deep, axially widened, and bordered by axial ends of major septa which are only slightly fused. Holotype with 24 major septa, of which five are in each cardinal quadrant and six in each counter quadrant; cardinal septum very short; counter septum slightly longer than neighboring majors. Minor septa short. Alar pseudofossulae slightly wider than other loculi. The figured paratype has 32 major septa, with six in each cardinal quadrant and nine in each counter quadrant; cardinal septum extends across axially swollen cardinal fossula and bends to the right; counter septum longer, higher, and thicker than neighboring majors. Alar pseudofossulae distinct. Minor septa almost absent and very short. Unfigured paratype with 31 major septa, of which each cardinal quadrant contains six, the right counter quadrant contains nine, and the left counter quadrant contains eight; cardinal septum short but extends straight across the nearly vertically-walled cardinal fossula near the bottom. Counter septum longer than neighboring majors and of the same thickness. Alar pseudofussulae quite distinct. Minor septa rather short at calyx margin. Calyx very deep, about 9 mm.

Dimensions—Holotype: length about 20 mm.; calical diameters 9 mm. by 10 mm. Dimensions of figured paratype: length about 16 mm.; calical diameters 10 mm. by 11.5 mm. Dimensions of unfigured paratype: length, about 22 mm. (incomplete); calical diameters 11 mm. by 12.5 mm.

Material.—Specimens studied: three. Holotype and paratypes, AMNH No. 6366/1.

Locality.—22 (type locality).

Occurrence.—Kinderhook beds, Burlington, Iowa.

Remarks.—The holotype has a carinate counter edge, giving it a cuneate shape, but the paratypes have circular cross-sections.

This species has been imperfectly understood for many years, indeed, the accompanying figures are the first to be published of the types.

The epitheca is smooth and apparently always was, contrary to the doubtful statement in the original description that the smoothness may be due to weathering. The "transverse septa" mentioned by White and Whitfield were questionably considered to be dissepiments by Williams (1943, p. 56). It is the confident belief of this writer that the "transverse septa" are really the tabulae as understood in recent usage. Inasmuch as early American students modeled their descriptions on European works, it is reasonable to assume that the concepts of vertical and horizontal septa reflect merely the translated French equivalents from such works as Haime's. Perforations in the peripheral portions of the "transverse septa" mentioned by White and Whitfield (and visible in the types) are nothing but occasional holes mechanically broken through the tabulae.

The specimens usually called *Z. acuta* will be considered by the writer in a forthcoming paper.

Genus TRIPLOPHYLLITES Easton, 1944

Diagnosis.—Simple, medium to large, curved corals. Cardinal fossula prominent. Alar pseudofossulae usually prominent. Major septa long, minor septa short. Tabulae usually well developed. Dissepiments usually sparse, commonly restricted to lower portions of the corallite.

Remarks.—When originally proposed it was stated (Easton, 1944, p. 39) that the genus might sometime be divided into two subgenera on the basis of the position of the cardinal fossula. At that time only *Zaphrentis reversa* Worthen, 1890 was thought possibly to possess the cardinal fossula on the convex side. Since that time several corals have been studied which require the division of *Triplophyllites* into two subgenera.

Subgenus TRIPLOPHYLLITES Easton, new usage

Diagnosis.—*Triplophyllites* with the cardinal fossula on the concave side of the corallite.

Type.—*Triplophyllites palmatus* Easton, 1944.

Remarks.—Most species of *Triplophyllites* belong here. It has been pointed out (Easton, 1944, p. 37) that *Zaphrentoides* may be a senior synonym of *Triplophyllites* but that the status of *Zaphrentoides* is so confused as to be (in the opinion of the writer) inapplicable at present. If the genus *Zaphrentoides* should be proved (by some future study of the genotype) to be the same as the genus *Triplophyllites*, then the subgenus *Triplophyllites* would be reassigned to the genus *Zaphrentoides*. (See under *Homalophyllites*).

The genus *Zaphrentoides* has been formally introduced into the literature of the North American Carboniferous by Moore and Jeffords for a Lower Pennsylvanian coral. These authors (Moore and Jeffords, 1945, pp. 129–130) reviewed the status of the genus and its position relative to several other genera and reached different working assumptions than the writer did in 1944. Subsequently, *Zaphrentoides* was used for certain Mississippian corals by Laudon et al. (1949, pp. 1502–1552), but without explanation. Dr. Laudon, (correspondence, 10 October 1949) informs me that the usage corresponds to what has been formerly known as *Triplophyllum*.

As interpreted herein, the subgenus contains both cuneate and normally conical corals. Two species-groups are set up to accommodate these different forms.

Triplophyllites palmatus species-group

Diagnosis.—*Triplophyllites* (*Triplophyllites*) with a circular cross-section.

Remarks.—Most species of *Triplophyllites* belong here.

Triplophyllites ellipticus species-group

Diagnosis.—*Triplophyllites* (*Triplophyllites*) with a cuneate cross-section.

Remarks.—*Zaphrentis ellipticus*, *Z. carinatus*, *Z. capuliformis*, *Z. clinatus*, and a new variety of the last species are referred to this species-group.

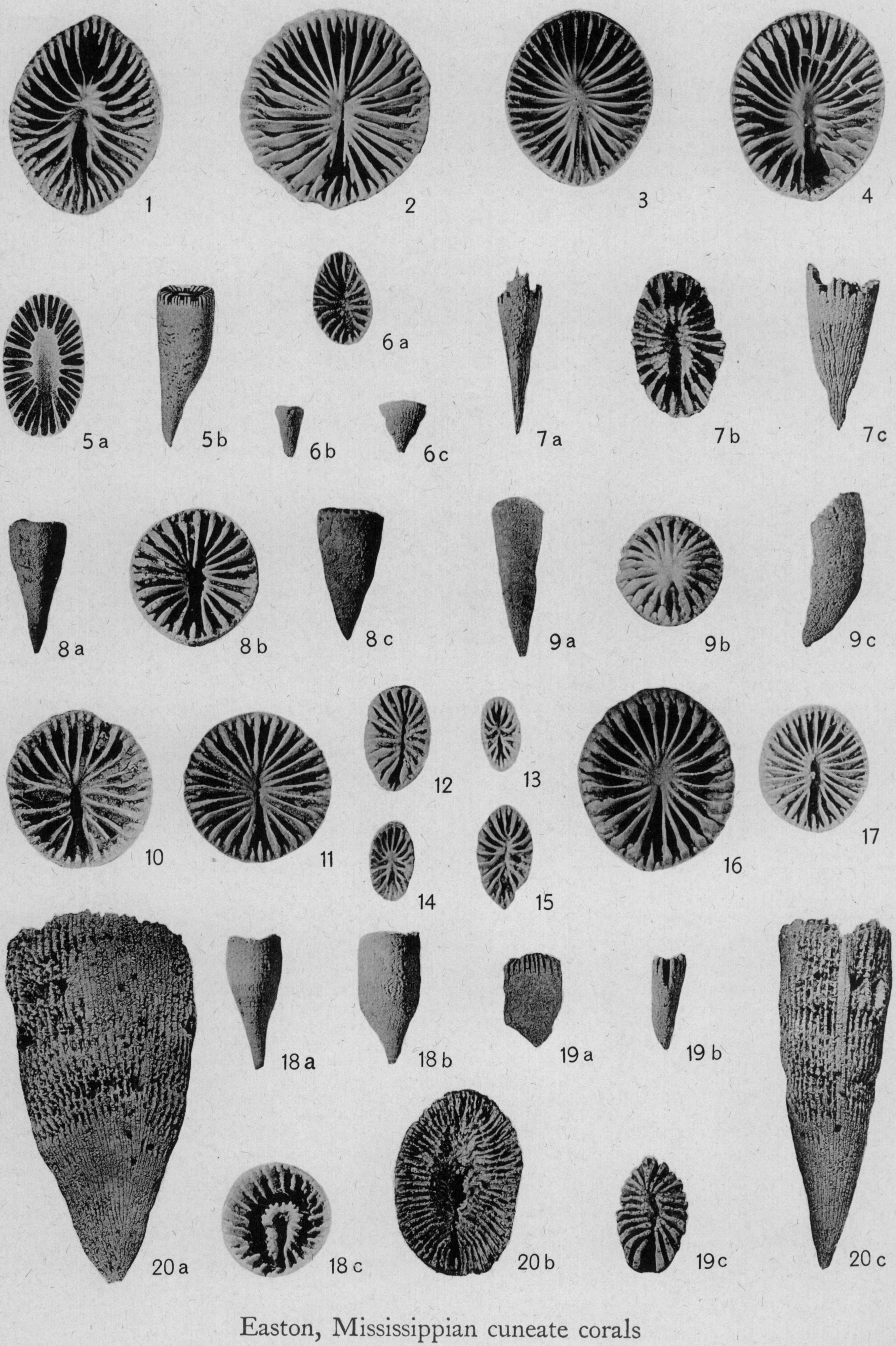
EXPLANATION OF PLATE 59

Calyces 2× except as otherwise indicated; lateral views 1×.

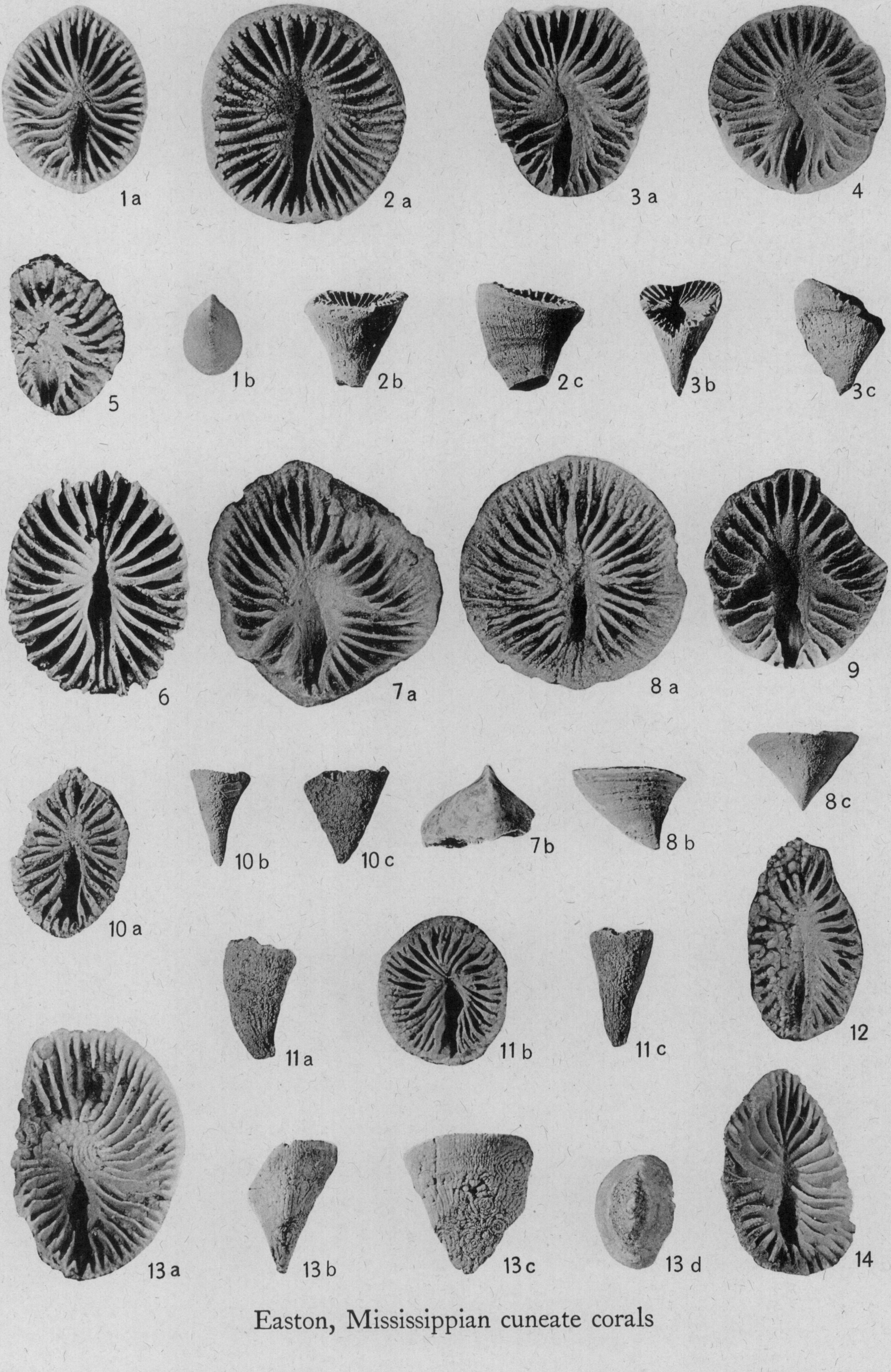
FIGS. *1–4*, *6*, *8–18*—*Triplophyllites* (*Homalophyllites*) *compressus* var. *lanceolatus* (Worthen), 1890. *1*, Calyx; approaches *T. clinatus;* USNM 115209a. *2*, Calyx in late maturity; AMNH 24006. *3*, Calyx; USNM 115208; approaches *T. clinatus*. *4*, Calyx; USNM 115208; approaches *T. clinatus*. *6a*, Calyx; *6b*, cardinal side; *6c*, left alar side; USNM 115212. *8a*, Cardinal side; *8b*, calyx; *8c*, left alar side; holotype of *Z. lanceolatus;* IGS (Worthen Coll.) 2572. *9a*, Cardinal side; *9b*, calyx; *9c*, left alar side; specimen less compressed than usual and more curved; USNM 37286. *10*, Calyx; USNM 115212. *11*, Calyx; AMNH 24003. *12*, Calyx in early maturity; AMNH 24004. *13*, Calyx in late youth; USNM 42878. *14*, Calyx in late youth; USNM 42878. *15*, Calyx in early maturity; USNM 42878. *16*, Calyx, AMNH 24005. *17*, Calyx; USNM 42878. *18a*, Cardinal edge; *18b*, right alar side; *18c*, calyx; USNM 115212. (p. 401)

5, *7*, *19*—*Triplophyllites* (*Homalophyllites*) *compressus* (Milne Edwards), 1857. *5a*, Calyx; "magnified"; from Milne Edwards; *5b*, lateral view of a specimen, probably not the same as *5a;* may actually be var. *lanceolatus;* "natural size"; from Milne Edwards; specimen lost. *7a*, Cardinal side; *7b*, calyx to match *5a;* *7c*, right alar side; USNM 115202a. *19a*, Left alar side; *19b*, cardinal side; *19c*, calyx; USNM 37286. (p. 399)

20—Genus and species unknown. *20a*, Left alar side; *20b*, calyx, 1×; *20c*, cardinal side; USNM unnumbered specimen. (p. 402)



Easton, Mississippian cuneate corals



Easton, Mississippian cuneate corals

TRIPLOPHYLLITES (TRIPLOPHYLLITES) ELLIPTICUS (White), 1862

Plate 61, figures 1–5, 15; text-figures 6, 7

1865. *Zaphrentis elliptica* WHITE, Boston Soc. Nat. Hist. Proc., vol. 9, p. 31 (1862).
1883. *Zaphrentis elliptica.* WHITE, Twelfth Ann. Rept., U. S. Geol. Geog. Survey Terr. etc., pt. 1, p. 155, pl. 39, figs. 7a, b. (Not figs. 4a, b.) (Advance printing, 1880).
1889. *Zaphrentis carniatus* [sic]. MILLER, North American Geology and Palaeontology, p. 208. (*Nomen nudum* and/or misspelling).
1889. *Zaphrentis elliptica.* MILLER, N. Amer. Geol. and Palaeontology, p. 209.
1889. *Z.* [*aphrentis*] *elliptica.* ROWLEY, Amer. Geol., vol. 3, no. 2, p. 115.
1890. *Zaphrentis carinatus* WORTHEN, Geol. Survey Illinois, vol. 8, p. 75, pl. 10, figs. 3, 3a.
1890. *Zaphrentis carinata.* WORTHEN, Geol. Survey Illinois, vol. 8, expl. pl. 10.
1893. *Zaphrentis elliptica.* ROWLEY, Amer. Geol., vol. 12, no. 1, p. 50.
1894. *Zaphrentis elliptica.* KEYES, Missouri Geol. Survey, vol. 4, p. 111, pl. 13, figs. 6a, b.
1897. *Zaphrentis elliptica.* KEYES & ROWLEY, Iowa Acad. Sci., vol. 4, p. 30.
1898. *Zaphrentis carinatus.* WELLER, U. S. Geol. Survey Bull. 153, p. 645.
1898. *Zaphrentis elliptica.* WELLER, U. S. Geol. Survey Bull. 153, p. 647.
1905. *Zaphrentis elliptica.* MERRILL, U. S. Nat. Mus., Bull. 53, pt. 1, p. 703.
1908. *Zaphrentis elliptica.* ROWLEY, Missouri Bur. Mines, ser. 2, vol. 8, p. 38.
1918. *Zaphrentis carinata.* BUTTS, Kentucky Geol. Survey, Mississippian Formations of Western Kentucky, pp. 29, 41 (1917).
1922. *Zaphrentis carinata.* CUMINGS, Handbook of Indiana Geology: Indiana Dept. Cons., Pub. 21, pt. 4, p. 508.
1928. *Zaphrentis elliptica.* WELLER, Missouri Bur. Geol. Mines, ser. 2, vol. 22, pp. 187, 190, 199.
1930. *Triplophyllum carinatum.* CRONEIS, Arkansas Geol. Survey Bull. 3, p. 49.
1943. *Z.* [*aphrentis*] *elliptica.* SCHUCHERT, Stratigraphy of the Eastern and Central United States. John Wiley and Sons, Inc., New York, p. 684.

Description of holotype of Z. elliptica *White.*—Coral a curved cone with an elliptical cross-section. Epitheca (slightly eroded) with broad encircling swellings and faint interseptal grooves. Apical portion rather sharply carinate at cardinal and counter positions.

Calyx (diameters 14 by 18 mm.) with a broad smooth floor sloping into the cardinal fossula. Cardinal fossula narrow peripherally and expanded axially with walls of fused axial ends of septa and inner floor consisting of a tabula sloping about 30° into the fossula. Alar pseudofossulae indistinct. Major septa number 38. Cardinal septum becomes very short in upper portion of fossula but traverses lower portion and leans slightly to the right. Right cardinal quadrant with eight septa, right and left counter quadrants with ten septa, and left counter quadrant with eight septa. Counter septum slightly longer and thicker than adjacent majors. Minor septa absent. Tabulae smooth, sloping toward cardinal fossula and down toward epitheca elsewhere.

Description of paratypes.—A well preserved paratype (diameters 13.5 by 16 mm) has the calyx inclined 30° toward the cardinal position. Cardinal fossula almost T-shaped axially. Septa number 35. Cardinal septum slopes down into the cardinal fossula and crosses it at its base, leaning to

EXPLANATION OF PLATE 60

Calyces 2×, lateral and apical views 1×.

FIGS. *1–6*, *10*—*Triplophyllites* (*Triplophyllites*) *clinatus* (Greene), 1904. *1a*, Calyx; *1b*, apical view; USNM 115206a. *2a*, Calyx; *2b*, left alar side; *2c*, cardinal side; paratype; AMNH 24044. *3a*, Calyx; *3b*, cardinal side; *3c*, left alar side; holotype; AMNH 24041. *4*, Calyx; paratype; AMNH 24043. *5*, Calyx; hypotype; USC 408. *6*, Calyx; supposed syntype of *Z. capuliformis;* UI, RX 11B. *10a*, Calyx; *10b*, cardinal side; *10c*, left alar side; one of the syntypes of *Z. lanceolatus;* IGS (Worthen Coll.) 2572. (p. 395)

7–9—*Triplophyllites* (*Triplophyllites*) *clinatus* var. *capuliformis* (Rowley), 1900. *7a*, Calyx; *7b*, oblique view along the trace of the counter septum; paratype; UI, RX 11A. *8a*, Calyx; *8b*, left alar side; *8c*, cardinal side; holotype; UI, RX 11. *9*, Oblique view into calyx; paratype; UI, RX 11C. (p. 397)

11—*Hapsiphyllum ulrichi* (Worthen), 1890. *11a*, Left alar side; *11b*, calyx; *11c*, cardinal side; holotype; IGS (Worthen Coll.) 2573. (p. 390)

12–14—*Triplophyllites* (*Triplophyllites*) *clinatus* var. *bicarinatus* Easton, n. var. *12*, Calyx; paratype; USC 406. *13a*, Calyx; *13b*, cardinal side; *13c*, right alar side; *13d*, apical view; holotype; USC 280. *14*, Calyx; paratype; USC 279. (p. 396) the left and lying in contact with the side of the counter septum. Right and left cardinal quadrants with six septa, one of these in each quadrant next to the cardinal septum being accidentally broken away at the calyx. Right counter quadrant with 11 majors, left counter quadrant with ten majors. Counter septum the same width as other septa, but longer, extending down the axial edge of the cardinal fossula as a ridge which overlaps the right side of the cardinal septum. Minor septa short, present only in counter quadrants. Alar pseudofossulae distinct.

Another paratype (diameters 11.5 by 14 mm.) has a narrow furrow at the inner end of the cardinal fossula, part of which furrow is occupied distally by the counter septum. Septa number 33. Right and left cardinal quadrants with five septa. Right counter quadrant with ten septa. Left counter quadrant with 11 septa. Counter septum longer than adjacent septa. All septa a trifle thickened except cardinal septum. Cardinal septum short leaning to left in floor of fossula. Alar pseudofossulae rather distinct. Minor septa absent.

A broken paratype shows the fibrous bundles of calcite in the septa inclined apically and axially at about 35°.

A paratype broken longitudinally in the cardinal-cardinal plane shows tabulae spaced 10 per cm., both complete and incomplete, peripherally recurved apically, and slightly irregular in spacing and strength. Dissepiments absent.

Dimensions.—Holotype: length, 25 mm. along alar septum.

Remarks.—White did not select a holotype for this species. The writer hereby selects the largest of his syntypes (UM 2084) figured herein (pl. 61, figs. 2 a–c) as the holotype.

This species seems to have been derived from *Neozaphrentis acuta* by completing the fusion of the septa bounding the lateral sides of the cardinal fossula, by increasing the size of the corallite and number of septa, by adding secondary septa, and by perfecting the cuneate tendency. This species is close enough to *Neozaphrentis* to give one an insight into the modifications which gave rise to at least one species group of *Triplophyllites*. The principal difficulty in the evolutionary picture concerns the general absence of dissepiments in this species. No dissepiments were observed in the syntypes, but a large specimen figured by section herein (pl. 61, fig. 15b) has a few dissepiments in late growth. It appears to the writer therefore, that the original concept of *Triplophyllites* must be changed somewhat so that the dissepiments should not be looked for principally in early stages of growth but should be expected to be developed according to the evolutionary stage represented by any particular species. Although this does not provide a sharp distinction between categories of corals, it seems to be all that can be said in the present state of our knowledge of North American corals of this genus. In recapitulation, it appears that the cuneate strain of *Triplophyllites* s.s. was derived from the non-dissepimented *Neozaphrentis acuta*. Advanced stages of *T. ellipticus* show true characters of *Triplophyllites* (such as are shown on pl. 61, figs. 15a, b, d.). Radiation from the type *ellipticus* could have given rise to *T. clinatus* and its relatives. Some of these possibly have dissepiments and others seemingly do not. One suspects that a polyphyletic group may be under consideration. The difficulty, of course, stems from lack of enough variable features to enable one to recognize supposed genetic strains. In any case, however, the species as considered herein are recognizable entities with stratigraphic usefulness. It is to be hoped that enough specimens may some day be collected to enable a student to make a detailed study of the ontogeny of these early *Triplophyllites* and to show patterns of change by percentages as in the case of *Z. delanouei* of Scotland,

In the interests of outlining philosophical problems raised by these particular species, I must point out that *T. ellipticus* as it exists in its types can logically be considered to be a related ancestor of *Clinophyllum.* The inclination of the calyx, nature of septal plan, and strength of the counter septum are quite in accord with this conjecture. On the contrary, the compression of the two groups is not in the same plane, so one cannot draw upon *T. ellipticus* as a near relative without interspersing intermediate forms which are not known to exist. Moreover, the stratigraphic distribution is wrong. More work needs to be done on the origin of *Clinophyllum*.

Description of the holotype of Z. carinata *Worthen.*—Corallite a curved and compressed cone, the apical region being somewhat flatter than the calical region. Epitheca smooth except for one deep depression near the calyx marking a period of rejuvenescence, and for several other faint encircling depressions. Calyx 8 mm. deep, ovate. Cardinal fossula narrow, deep, and located on the concave side of the corallite. Major septa number 32 or 33, there being about five in each cardinal quadrant and ten in each counter quadrant. The cardinal septum is very short. The counter septum is shorter than neighboring majors and lies in a shallow fossula.

Dimensions.—Length (incomplete) of cardinal side, 20 mm.; calical diameters 16 mm. by 13.5 mm.

Description of hypotypes.—Three specimens from Quarry, Iowa, have the external features of the species. One of these has been sectioned.

Section in early maturity (12 by 15 mm.).—Septa very much thickened by stereoplasm, the axial portion being a dark line. Loculi very narrow, with tabular intersections but no dissepiments observed. Cardinal septum very long, narrow, slightly swollen axially. Counter septum slightly thicker than adjacent majors. Alar pseudofossulae slightly wider than adjacent loculi. On one half of the section there are five septa in the cardinal quadrant and ten in the counter quadrant. Total septa probably 32. Minor septa absent.

Section in late maturity (diameters 14 by 17 mm.).—Septa slightly thickened by stereoplasm and with a dark axial line. Cardinal septum long, but discontinuous (probably with a central sag along its upper edge causing it to leave the plane of the section and then reenter it) and bent to the right. Cardinal fossula very much swollen axially. Counter septum half again as thick as adjacent septa. Six septa in each cardinal quadrant and 12 in each counter quadrant, total being 38. Septa are somewhat withdrawn from the axial region. Minor septa not observed. Tabulae in axis and between septa. Dissepimental intersections sparse. Alar pseudofossulae distinct.

At a slightly later stage minor septa appear and dissepiments are distinctly present. Septal retreat is more pronounced. Cardinal septum is shorter.

Localities.—15, 16, 17 (type locality), 18.

Occurrence.—This species occurs in the Maynes Creek member of the Hampton formation of Iowa and in the "Keokuk group" of Kentucky.

Material.—Specimens studied: 11. Syntypes, UM (White Coll.) No. 2084. Figured hypotype (this paper), USNM No. 115203A. White's figured hypotype, USNM 115203B. Unfigured hypotypes, USNM No. 115204.

TRIPLOPHYLLITES (TRIPLOPHYLLITES) CLINATUS (Greene), 1904

Plate 60, figures 1–6, 10; text-figure 9

1890. [*?Zaphrentis lanceolatus*]. WORTHEN, Illinois Geol. Survey, vol. 8, pl. 10, fig. 4b.
1904. *Zaphrentis clinatus* GREENE, Contributions to Indiana Palaeontology, pt. 19, p. 187, pl. 56, figs. 6–9.
1906. *Zaphrentis clinatus*. BEEDE, in Cumings and Beede, Indiana Dept. Geol. Nat. Res., 30th Ann. Rept., pp. 1204, 1373, pl. 11, figs. 1–1c.
1922. *Z.* [*aphrentis*] *clinatus*. CUMINGS, Handbook of Indiana Geology: Indiana Dept. Cons., Pub. 21, pt. 4, p. 505.

Description of holotype.—Corallite a modified elliptical cone curved in the direction of the cardinal fossula. The cross-section is tear drop shaped almost to the calyx, where it becomes ovate; the pointed edge of the tear drop cross-section follows the trace of the counter septum. The corallite is compressed more on the counter than on the cardinal side and has therefore one acute edge and one rounded edge. Theca with faint longitudinal markings.

Calyx shallow, 3 mm. deep at the inner edge of the fossula. Cardinal fossula deep, narrower at the ends than in the middle, flaring at the calyx floor. Alar pseudofossulae longer and slightly wider than other loculi. Counter fossula shallow, resulting only from the depression of the counter septum. Cardinal septum very short in the calyx but reaching the inner edge of the cardinal fossula at its floor and leaning to the right. Right and left cardinal quadrants with six major septa and no minors. Right and left counter quadrants with ten major septa. Minor septa are best developed in the right counter quadrant; all are very short. Alar septa slightly higher than other septa in cardinal quadrants, and, therefore, extend onto the calyx floor. All 34 major septa meet to form the fossular wall. Tabulae not observed. Theca rather thick.

Dimensions.—Holotype 18.5 mm. high; calyx 14.5 mm. long and 12 mm. wide. One paratype's calyx is 14 mm. × 13 mm.; another is 16.5 mm. by 15 mm.

Paratypes.—The smallest paratype (calical diameters 8.5 mm.×11 mm.) has 31 major septa, no minor septa. Alar pseudofossulae are distinct.

The second paratype (diameters 13 mm.×14 mm.) has 33 major septa, a few minor septa in the counter quadrants, indistinct alar pseudofossulae, and a depression on the calical floor on the counter side of the cardinal fossula.

The largest paratype (diameters 15.5 mm.×16.5 mm.) has 33 major septa, minors in all but a few loculi, and fairly distinct alar pseudofossulae.

Material.—Specimens studied: 14. Holotype: AMNH Nos. 24042–24044. Hypotypes: USC Nos. 281, 408; syntype of *Z. lanceolatus* Worthen, 1890, pl. 10, fig. 4b: IGS (Worthen Coll.) No. 2573; USNM Nos. 115205, 115206, 115206a; UI (Rowley Coll.) No. RX 11B which is a syntype of *Z. capuliformis*.

Localities.—1, 3, 4, 5, 23?.

Occurrence.—The species is known with certainty from the Warsaw (Harrodsburg) and Salem limestones. It is known doubtfully from the lower Burlington limestones.

Remarks.—The syntypes of *Z. capuliformis* contain one specimen (UI No. RX 11B) which is a typical *T. clinatus*. The mode of preservation closely resembles that of corals from the Salem limestone at Lanesville and some other localities in Indiana. It is not at all like typical Burlington preservation. Although one cannot say definitely that it did not come from the lower Burlington limestone at Louisiana, Missouri, one certainly is prone to doubt it.

The calyx of this coral (diameters 13 by 16 mm.) has a long cardinal fossula extending two-thirds the calical diameter and is broadest about two-thirds of the length, tapering at both ends. Major septa total 32. Cardinal septum is a short ridge which only reaches the deepest part of the fossula. Cardinal quadrants each with six major septa and only rare indistinct minor septa. Counter quadrants each with nine major septa (the first of each being very short) and short minor septa. Counter septum shorter and lower than adjacent majors. The counter edge of the coral has a low sharp keel.

TRIPLOPHYLLITES (TRIPLOPHYLLITES) CLINATUS var. BICARINATUS Easton, n. var.

Plate 60, figures 12–14; text-figure 10

Diagnosis.—*Triplophyllites clinatus* with a keel centered at the position of the cardinal septum as well as having one at the position of the counter septum.

EXPLANATION OF PLATE 61

Calyces and sections 2× except as noted, lateral and apical views 1×.

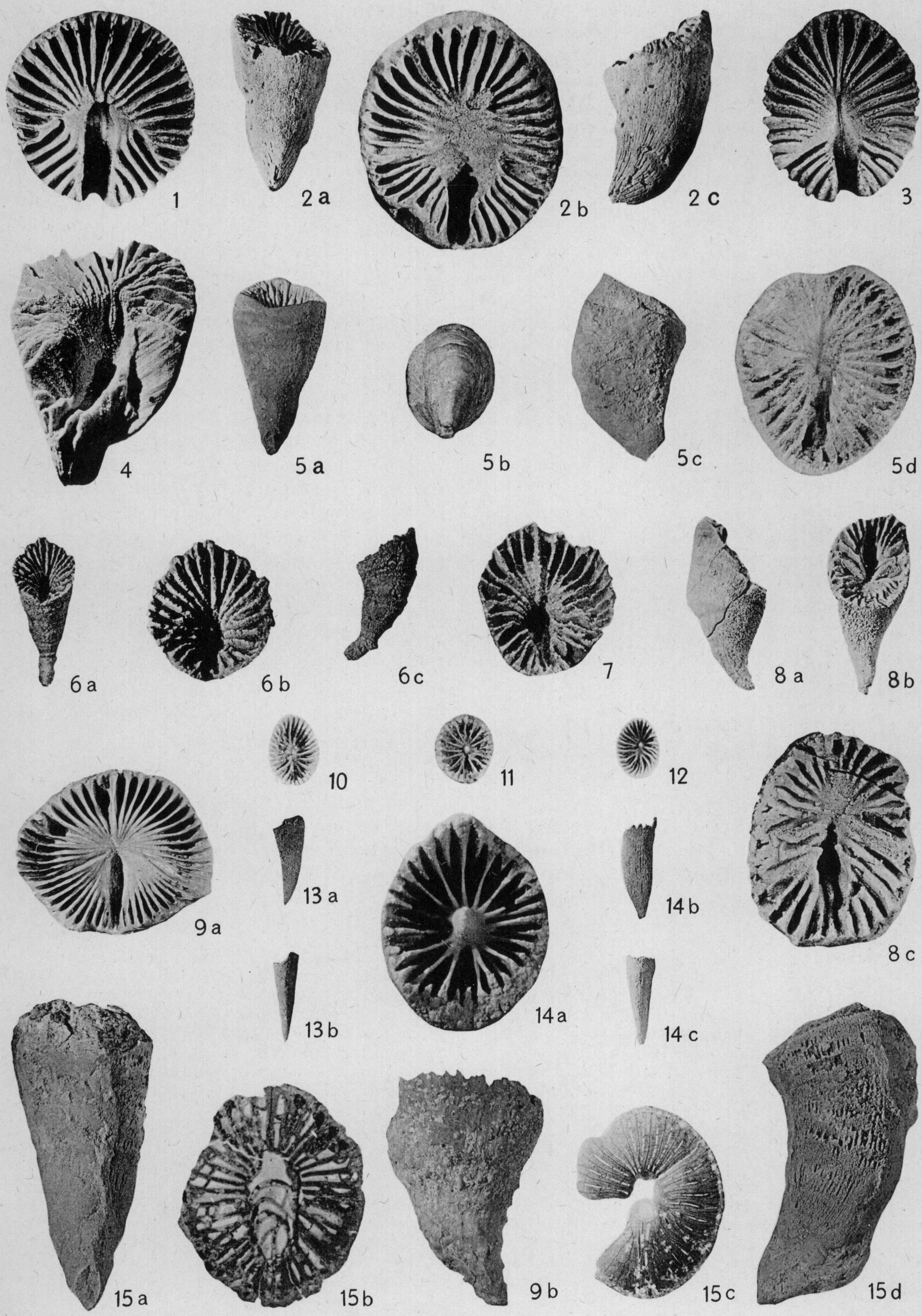
FIGS. *1–5, 15*—*Triplophyllites* (*Triplophyllites*) *ellipticus* (White), 1862. *1*, Calyx; paratype. *2a*, Cardinal side; *2b*, calyx; *2c*, right alar side; holotype. *3c* Calyx; paratype. *4*, Side view from broken right cardinal quadrant into interior, showing nature of septal fibers, 2×; paratype; figures *1–4* UM (White Coll.) 2084. *5a*, Cardinal side; *5b*, apical view; *5c*, left alar side; *5d*, calyx somewhat obscured by chert filling; holotype of *Z. carinata* Worthen; IGS (Worthen Coll.) 2564. *15a*, Cardinal side; *15b*, section in late maturity; *15c*, section in early maturity; *15d*, right alar side; hypotype; USNM 115203a; this specimen illustrates stages later than that present in the holotype. (p. 393)

6, 7—*Neozaphrentis acuta* (White & Whitfield), 1862. *6a*, Cardinal side; *6b*, calyx; *6c*, right alar side; holotype; AMNH 6366/1. *7*, Calyx; paratype; AMNH 6366/1. (p. 391)

8—*Triplophyllites* (*Homalophyllites*) sp. UA (Stoyanow Coll.) unnumbered. *8a*, Right alar side; *8b*, counter side; *8c*, calyx. (p. 399)

9—*Triplophyllites* (*Homalophyllites*) *reversus* (Worthen), 1890. *9a*, Calyx, 1×; *9b*, right alar side; holotype; IGS (Worthen Coll.) 2567. (p. 398)

10–14—*Cyathaxonia venusta* (Greene), 1904. *10*, Calyx; hypotype; AMNH 24045. *11*, Calyx; hypotype; AMNH 24046. *12*, Calyx; hypotype; AMNH 24047. *13a*, Left alar side; *13b*, cardinal side; hypotype; AMNH 24048. *14a*, Calyx, 6×; *14b*, right alar side; *14c*, cardinal side; holotype; AMNH 23412. (p. 388)



Easton, Mississippian cuneate corals

Description.—Holotype with faint longitudinal markings following the traces of the septa. Major septa 34 alternating with very short minors; five majors in each cardinal quadrant. Positions of a tabula are visible in the cardinal fossula. Alar pseudofossulae indistinct. Otherwise as in *T. clinatus.*

Dimensions.—Holotype: length, 21.5 mm. (incomplete); greatest diameter of calyx, 19 mm.; least diameter of calyx, 13 mm. (incomplete).

Comparison.—This variety differs from the typical form of the species in having two sharp edges due to compression, and in being compressed even at the calical rim.

Material.—Specimens studied: 17. Holotype, USC No. 280. Figured paratypes USC No. 279, 406. Unfigured paratypes, USC No. 282. Topotypes, USC No. 407. Figured hypotypes USC No. 408. Other specimens, USC No. 405.

Localities.—6, 7, 8.

Occurrence.—The type locality is near the base of the upper Warsaw (Harrodsburg) limestone (Meramecian series, Mississippian system) in an exposure about 4 feet high on the north side of highway 62, between the two quarries and the bridge over Little Indian Creek, between Corydon and Lanesville, Indiana.

Remarks.—This variety grades into typical *T. clinatus.*

TRIPLOPHYLLITES (TRIPLOPHYLLITES) CLINATUS var. CAPULIFORMIS (Rowley), 1900

Plate 60, figures 7–9; text-figure 8

1900. *Zaphrentis capuliformis* ROWLEY, Amer. Geol., vol. 25, no. 5, p. 270, pl. 5, figs. 67–70. (in part).

1908. *Zaphrentis capuliformis.* ROWLEY, Missouri Bur. Geol. Mines, ser. 2, vol. 8, p. 38.

Description of holotype.—Corallite (UI No. RX 11) a simple short, flaring, cone, curved toward the cardinal fossula and with an elliptical cross-section. The keel at the counter position is weakly developed. Epitheca with faint encircling striae and a few indistinct encircling constrictions. Calyx (diameters 16.5 by 17.5 mm.) 3 mm. deep with a broad floor developed on the axial portions of the septa. Cardinal fossula deep, narrower at its midlength than at either end, and bounded laterally by the fused ends of septa. Cardinal septum indistinct. Major septa total 36. Right and left cardinal quadrants with six major septa of which the first on either side of the cardinal septum is indistinct. Right counter quadrant with 11 major septa of which the first adjacent to each alar pseudofossula is very short. Counter septum axially swollen and longer and little higher than adjacent majors which converge pinnately toward it. Alar pseudofossulae prominent but narrow. Minor septa as septal ridges. Tabulae presumably are responsible for the floor of the cardinal fossula. Dissepiments possibly present in right counter quadrant.

A paratype (UI RX 11A) (diameters 17 by 18.5 mm. incomplete) has eight majors in the right cardinal quadrant and 11 in each of the counter quadrants. The left cardinal quadrant is obliterated. The counter septum is longer and higher than the adjacent pinnately arranged majors, but is not axially swollen. Minor septa are short. Perhaps the calyx originally contained 40 major septa. The counter edge of the coral is produced into a prominent ridge-like keel.

Another paratype (UI No. RX 11C) (diameters 13.5 by 15 mm.) has six majors in each cardinal quadrant and nine in each counter quadrant. The counter septum is longer and higher than the adjacent pinnately arranged majors and is axially swollen. Major septa total 32.

Dimensions.—Holotype: 11 mm. high; alar septum 15 mm. long.

Material.—Specimens studied: 3. UI (Rowley collection). Holotype: (Rowley, 1900, pl. 5, figs. 67, 68) RX 11. Largest paratype (Rowley, 1900, pl. 5, figs. 69, 70). RX 11A. Poorest paratype: RX 11C.

Occurrence.—Localities: 23 (type locality), 24.

Remarks.—Rowley did not designate a holotype but he did mention (Rowley, 1900, p. 273) that figs. 67, 68 of his plate 5 represented views of "one of the types." This specimen which he figured, which is University of Illinois (Rowley collection) No. RX 11, is hereby designated the holotype. The other three specimens, which he may or may not have intended to be syntypes, become paratypes. One of these

(UI, RX 11B) is described under *T. clinatus* instead of with the other types.

The dissepiments mentioned in the description of the holotype are a few blister-like swellings on the calical walls. It cannot be said that they are definitely dissepiments without sectioning them; this operation was not done.

This variety of *T. clinatus* contains enough variation among the types to show how modifications gave rise to the typical form. By comparing the figures, one can observe the *T. clinatus* trend going from the holotype (RX 11) to the two paratypes (first RX 11A and then RX 11C).

Rowley's figures of the calices are largely based on presumption. The writer cleaned considerable matrix out of all the specimens in order to reveal their characters.

I do not find any ridge on the cardinal side of the corals, which Rowley said was more or less distinct. At best the corals are only sharply rounded there as a result of their having elliptical cross-sections.

Mature specimens of this variety may be distinguished from the typical form by having a more widely flaring shape, more numerous septa, and a thinner epitheca. Otherwise they are quite similar.

Subgenus HOMALOPHYLLITES Easton, 1944 emended

Diagnosis.—*Triplophyllites* with the cardinal fossula on the convex side of the corallite.

Type.—*Lophophyllum calceola* White and Whitfield, 1862.

Remarks.—Previously the writer (Easton, 1944, p. 42) revised the concept of *Hapsiphyllum* Simpson, 1900 to include corals with the features of *Lophophyllum calceola*. The subgenera *Hapsiphyllum* and *Homalophyllites* were established at the same time. Although that seemed to provide an orderly systematic arrangement at that time, it is not found to be satisfactory now. The writer subsequently has seen many specimens of corals similar to *L. calceola* and *Hapsiphyllum calcariforme* in new species to be described or redescribed in the future. It is concluded that the subgenus *Homalophyllites* should be separated from the genus *Hapsiphyllum* and assigned to the genus *Triplophyllites*.

If *Zaphrentoides* should be proved to be the same as *Triplophyllites* then the subgenus *Zaphrentoides* can be used to replace *Homalophyllites* of this paper. This would revive the taxonomic category established by Schindewolf in 1938 for the particular corals with the cardinal fossula on the convex side of the corallite. It would not, however, revive Schindewolf's usage of the subgenus *Hapsiphyllum*.

Corals with circular cross-sections, cuneate, and calceolid shapes occur in this subgenus. Species groups are established to segregate the three categories.

Homalophyllites calceolus species group

Diagnosis.—*Homalophyllites* with a calceolid shape.

Remarks.—*Lophophyllum calceola* White and Whitfield, 1862 belongs here.

Homalophyllites reversus species group

Diagnosis.—*Homalophyllites* with a circular cross-section.

Remarks.—The writer (Easton, 1944, p. 39) once theorized that *Z. reversa* Worthen, 1890 might warrant the separation of *Triplophyllites* into subgenera on the basis of location of the cardinal fossula with respect to curvature. At that time *Z. reversa* had not been figured and so was poorly known. It and other corals considered herein are known now to fit the requirement formerly stated for the recognition of the atypical subgenus. *Z. reversa*, however, is not a suitable type for reasons stated below.

TRIPLOPHYLLITES (HOMALOPHYLLITES) REVERSUS (Worthen), 1890

Plate 61, figures 9a, b

1889. *Zaphrentis reversa* MILLER, North American Geology and Palaeontology, p. 210. (nomen nudum).
1890. *Zaphrentis reversa* WORTHEN, Geol. Survey Illinois, vol. 8, p. 78.
1898. *Zaphrentis reversa.* WELLER, U. S. Geol. Survey Bull. 153, p. 648.

Description of holotype.—Coral a curved cone with an apical angle of 40–45°. Theca with short spines arranged more or less in concentric bands, with broad undulations of growth, and with faint longitudinal striations. Calyx moderately deep (9 mm. deep to floor of calyx). Cardinal fossula deep, on the convex side of the corallites, extending to the center of the calyx, and widest about ⅔ of the way to the center. Alar pseudofossulae prominent. Major septa number 49, and most of them extend across the calical floor. Cardinal septum extends straight across the cardinal fossula at its floor but is very short above the fossular floor. Right and left cardinal quadrants each contain ten septa, of which the alar septa are slightly more robust than the others. Right counter quadrant contains 14 majors. The counter septum is slightly more robust and is slightly higher than its neighbors. In the left counter quadrant, the seventh and thirteenth septa (counting clockwise) are aborted and their positions are marked by extra wide loculi.

Material.—Specimens studied: 1. Holotype and only known specimen, IGS (Worthen Collection) No. 2567.

Type locality.—Warsaw beds, near Columbia, Monroe Co., Illinois.

Locality.—14 (type locality).

Remarks.—Only one specimen of the species is known, although numerous paleontologists have collected from beds of Warsaw age. Under the circumstances, the specimen may be merely a sport. Moreover, the specimen is known to be aberrant in the abortion of the seventh and thirteenth septa of the left counter quadrant. Not only are these septa reduced to ridges, but their allotted position near the axis has been taken over by adjacent septa. This indicates that the shortening of the two septa took place during the earlier ontogeny of the creature. In view of these things, it may be that the species group may contain only this one species among American Mississippian corals.

T. reversus has not been figured previously, probably because extensive preparation was necessary before the calyx was cleaned of matrix.

Homalophyllites compressus species group

Diagnosis.—*Homalophyllites* with a cuneate shape.

Remarks.—*Zaphrentis compressa*, *Z. lanceolata* and an undescribed species from Arizona belong here.

TRIPLOPHYLLITES (HOMALOPHYLLITES) sp.
Plate 61, figures 8 a–c; text-figure 12

Remarks.—The specimen discussed below was very kindly lent by Dr. Alexander Stoyanow from his collection. The species will be described by Dr. Stoyanow in a forthcoming article on the index fossils of Arizona, but he has graciously consented to the publication of this statement so that all of the cuneate corals known to the writer may be included in this paper.

The specimen is slightly cuneate and has the cardinal fossula on the convex side of the coral. It is similar to *T.* (*T.*) *ellipticus* in most respects except for location of the cardinal fossula with respect to curvature. It also resembles *Clinophyllum* except that the inclination of tabulae and location of cardinal fossula are reversed with regard to curvature. In the course of time the phylogenetic relationships of *Clinophyllum* to *Triplophyllites* should be studied critically when enough species and specimens allied to this specimen from the Escabrosa limestone are known.

TRIPLOPHYLLITES (HOMALOPHYLLITES) COMPRESSUS (Milne-Edwards), 1857
Plate 59, figures 5, 7, 19; text-fig. 5

1857. *Zaphrentis compressa* MILNE-EDWARDS, Histoire Naturelle des Coralliaires ou Polypes Proprement Dits, Atlas, pl. G1, fig. 3.
1860. *Zaphrentis compressa.* MILNE-EDWARDS, Histoire Naturelle des Coralliaires ou Polypes Proprement Dits, vol. 3, p. 342.
1876. not *Zaphrentis compressa* ROMINGER, Geol. Survey Michigan, vol. 3, pt. 2, p. 151, pl. 52 [=*Z. davisana* Miller, 1889, p. 209].
1889. *Zaphrentis compressa.* MILLER, N. Amer. Geol. and Palaeontology, p. 208.
1898. *Zaphrentis compressa.* WELLER, U. S. Geol. Survey Bull. 153, p. 646.
1904. *Zaphrentis compressa.* GREENE, Contributions to Indiana Palaeontology, pt. 18, p. 177, pl. 52, figs. 8–11.
1906. *Zaphrentis compressa.* BEEDE, in Cumings and Beede, Indiana Dept. Geol. Nat. Res., 30th Ann. Rept., pp. 1204, 1373, pl. 7, figs. 4–4d.
1922. *Triplophyllum compressa.* BUTTS, Kentucky Geol. Survey, ser. 6, vol. 7, pp. 110, 112–116.
1922. *Zaphrentis compressus.* CUMINGS, Handbook of Indiana Geology, Indiana Dept. Cons., Pub. 21, pt. 4, p. 505.
1930. *Zaphrentis compressa.* MORSE, Mississippi Geol. Survey Bull. 23, p. 110.

1943. *Triplophyllum compressa.* McFarlan, Geology of Kentucky, p. 75.
1943. *Triplophyllum compressum.* Schuchert, Stratigraphy of the Eastern and Central United States. John Wiley and Sons, Inc., New York, p. 531.
1943. *Z.* [*aphrentis*] *compressa.* Schuchert, Stratigraphy of the Eastern and Central United States. John Wiley and Sons, Inc., New York, p. 591.

Translation of Original Description

Corallite strongly compressed, cuneiform, narrow, pointed at the bottom, straight or scarcely curved in the direction of the large axis of the calyx. Growth lines very little developed. Calyx elliptical, of which the little axis amounts to nearly half the large axis. The uppermost tabula is only flat at the axis for a short distance. The oblong septal [cardinal] fossula is well developed and very deep, located on the side of large curvature. Septa 22, subequal, strong, a little thickened in their outer half, well developed, straight, and alternating with an equal number of very small septa. Height of corallite, 2½ centimeters; large axis of the calyx at least 1 centimeter.

Carboniferous formation: Spurgen [sic] Hill (Indiana).

We consider as a variety of this species a corallite, (pl. G1, fig. 4) from the same locality, which is much shorter and wider than the specimens previously described, the uppermost tabula of which is flat for a greater extent, and in which there are 30-odd major septa.

Remarks.—Milne-Edwards figured only one of the species referred to above. These figures are reproduced herein. The unnamed variety of this species, which he mentioned in the text as being figure 4 on plate G1, does not appear there or elsewhere in the Atlas, nor is it mentioned in the legends accompanying the figures.

All efforts to locate the type specimens have been unavailing. Although Milne-Edwards states (1860, p. 342) that the specimens were discovered by Casseday, he does not say what disposal was made of them. M. Ranson, of the Museum d'Histoire Naturelle in Paris assures me that they are not there. Casseday's collection is missing, but rumor has it that some of it, at least, was at the St. Louis Academy of Sciences for a time.

Lacking the types, the writer has selected a specimen as principal hypotype (USNM No. 37286) which agrees very closely with the best figure given by Milne-Edwards (1857 (Atlas), pl. G1, fig. 3b). M. Ranson has pointed out to the writer that there is good reason to believe that figures 3 b and 3a in the work just referred to are actually different specimens. The explanation of the plates in that work frequently distinguishes between two views of the same specimen, as opposed to views of different specimens. Inasmuch as a definite statement such as "Calice du même, grossie" is lacking and one only finds "Calice grossi," the evidence is strong that Milne-Edwards had two specimens before him.

A further problem concerns on which side of the specimen the cardinal fossula is located. The figures do not help one to decide. The description says merely that the fossula is on the side of "la grande courbure." If one understands this to mean the most curved side, then the connotation is of greatest radius of curvature and the fossula would be on the concave side when viewed from an alar side. If one understands Milne-Edwards to have indicated a side with a long arc as opposed to a side with a short arc, then the fossula would be on the convex side. Fortunately, Milne-Edwards (and his colleague Haime) were singly and collectively consistent in their usage of the particular phraseology. By checking descriptions of species whose location of cardinal fossulae is known and by comparing illustrations with accompanying descriptions of other species, one can demonstrate to one's own satisfaction that "la grande courbure" means the convex side when viewed from an alar side.

Having eventually discovered what *Zaphrentis compressa* is like, the writer selected a specimen which agrees very closely with figure 3b of Milne-Edwards. This (largest) specimen, from the same locality, is described below as a hypotype.

Description of hypotypes of Homalophyllites compressa.—Largest specimen narrowly elliptical throughout, straight. Epitheca somewhat eroded showing septal traces. Calyx with very prominent elongate cardinal fossula whose floor slopes down steeply from the slightly sloping smooth calical floor. Cardinal septum short at distal end but reaching across fossula proximally and slightly bent to the right. Counter septum slightly longer than other majors. Cardinal quadrants each contain four major septa. Counter quadrants each contain seven major septa. Total major septa, therefore, number 24. Minor septa intercalated between some major septa. Alar pseudofossulae very weakly developed. Length, 25 mm.; calical diameters, 7 by 11 mm.

Three specimens are distinctly curved. In each, the cardinal fossula is on the convex side. Several specimens show the epitheca to have been smooth except for occasional encircling furrows. Some specimens may expand, then diminish their diameter, and expand again. In such instances, that portion including the latter expansion is usually less compressed than the rest of the calyx. The counter septum may be long, short, thick, thin, in a faint fossula, or lacking fossular expression. As variable as it is, it is curious that something usually distinguishes it in single or combined form from the preceding list.

Material.—Specimens studied: ten. Figured hypotypes: USNM No. 37286. Other hypotypes, USNM Nos. 115202, 115202a. Other specimens: USNM No. 115211.

Localities.—6, 10, 11.

Occurrence.—*T.* (*H.*) *compressus* occurs in the Salem limestone.

TRIPLOPHYLLITES (HOMALOPHYLLITES) COMPRESSUS var. LANCEOLATUS (Worthen), 1890

Plate 59, figures 1–4, 6, 8–18; text-figure 4

1889. *Zaphrentis lanceolata* MILLER, North American Geology and Palaeontology, p. 209 (nomen nudum).
1890. *Zaphrentis lanceolatus* WORTHEN, Geol. Survey Illinois, vol. 8, p. 76, pl. 10, figs. 4, 4a (in part).
1890. *Zaphrentis lanceolata*. WORTHEN, Geol. Survey Illinois, vol. 8, expl. pl. 10.
1898. *Zaphrentis lanceolata*. WELLER, U. S. Geol. Survey Bull. 153, p. 648.
1926. *Triplophyllum* (*Zaphrentis*) *compressa*. BUTTS, Geol. Survey Alabama, Spec. Rept. 14, p. 173.
1926. *Zaphrentis compressa*. BUTTS, Geol. Survey Alabama, Spec. Rept. 14, p. 56, figs. 6, 7.

Description of holotype of Zaphrentis lanceolatus *Worthen, 1890.*—Corallite in the form of an elliptical cone with slight obliquity toward the cardinal fossula. The cross-section changes from the apex so that in the proximal portion the cross-section is a narrow ellipse, but in the distal portion it becomes less excentric, and, therefore, is broadly elliptical at the calyx rim. Theca smooth except for faint encircling wrinkles.

Calyx shallow (about 3 mm. deep) and with the septa everted about 1 mm. beyond the thecal rim. The outer fourth of each major septum slopes down abruptly to the theca but gradually to the calyx floor. Cardinal fossula deep, narrow, and parallel-sided in the inner half. Alar pseudofossulae not differentiated but the position of the alar septum can be approximated by the slight bunching together of septa into four groups. Cardinal septum reaches almost to the axis in the floor of the fossula and is directed slightly to the left (when the cardinal fossula is orientated downward). In the calyx the cardinal septum extends about one-third the radius. Counter septum is a trifle longer and higher than the other majors near the axis, but is entirely similar to them near the theca. The calyx contains 22 major septa distributed as follows: the cardinal septum, four in each cardinal quadrant, six in each counter quadrant, and the counter septum. Short minor septa are distributed alternately with the majors. The minor septum on either side of the cardinal septum is longer than the other minors in the lower portion of the fossula and fuses with the next major septum at the fossular wall. These two minor septa are presumably short primary septa, whereas the other minors are secondary septa. Major septa coalesce axially to form a sloping calical floor of stereom. Tabulae were not observed, unless the floor of the fossula is a tabula.

Dimensions.—Height: 21 mm. Long dimension of calyx: 10 mm. Short dimension of calyx: 9 mm.

Localities.—1, 5, 6, 9, 10, 19 (type locality), 13, 20, 21, 25.

Material.—Specimens studied: 64. Holotype: IGS (Worthen collection) No. 2572. Other material: AMNH Nos. 24003–24006 (Greene's figured hypotypes of *Zaphrentis compressa*); USNM No. 71629 (Butt's figured hypotype of *Zaphrentis compressa*), 50771, 42878, 41229, 115207–115210.

Remarks.—Worthen left two syntypes of this species. One of these, which fits his measurements of an "average size specimen" and which he figured on pl. 10, figs. 4, 4a, is here designated the holotype.

The other syntype was figured on pl. 10, fig. 4b, but there is no mention of this figure in the text or in the explanation of plate 10. The measurements of the specimen fit the two recognizable dimensions of the figure but do not correspond to the measurements given on p. 76 for the "Broadest specimen." Perhaps Worthen took his measurements from the plate and not from the specimen. The specimen is referred in this report to *Triplophyllites clinatus*.

Worthen reports the type locality as "Warsaw beds of the St. Louis group, Spergen Hill, Indiana, and Coalsburg [sic], Ky." The famous collecting locality at Spergen Hill is in the Salem limestone (Iowan series of the Mississippian). There is no Salem limestone around Colesburg, but a good section of the underlying Warsaw limestone and shale is present from which collectors have obtained good faunas through the years. The label accompanying the syntypes reads only "Warsaw beds Coalsburg [sic], Kentucky," hence, this affords presumptive evidence that the syntypes are from the Warsaw formation at Colesburg, Kentucky.

Other specimens before the writer were collected by Greene and constitute the hypotypes to substantiate his identification of *Zaphrentis compressa.* Their label reports them to be from Lanesville, Spergen Hill, and Georgetown, all in Indiana. The first two of these references and probably the third constitute occurrences in the Salem limestones, but one cannot decide which of his specimens came from what locality.

In summation, then, this variety appears to occur in the Warsaw formation and Salem limestone.

The location of the cardinal fossula with respect to curvature is variable in this variety. Most specimens are simply straight cones and so have no convex or concave side. Some other specimens are very slightly curved in the apical portions only, in which cases one finds some specimens to have the fossula on the convex side and others to have it on the concave side. Of the 48 specimens before me which should afford evidence, the location of the fossula with regard to curvature cannot be decided for 32 specimens; is on the concave side of five specimens; and is on the convex side of 11 specimens.

INCERTAE SEDIS

Gen. nov. et sp. nov.

Plate 59, figures 20a–c; text-figure 13

Description.—Corallite simple, large, cuneate. Epitheca eroded to show septal traces, otherwise with only faint broad incircling swellings. Calyx with central depression floored by a tabula on whose surface are septal traces. Cardinal septum very short. Right cardinal quadrant with ten major septa; right counter quadrant with 16 major septa; counter septum joined on either side by contratingent minor septa; left counter quadrant with 20 major septa; left cardinal quadrant with eight major septa; total major septa—56. Minor septa short and contratingent with the major septa. The major septa of the cardinal quadrant are pinnately arranged around the cardinal fossula. Tabulae depressed proximally at the axial region and at their periphery, but bent upward about half the distance from the axis to the periphery.

Dissepiments in as many as two (and possibly more) ranges distally, but seemingly absent proximally. Six dissepiments occur in 1 cm.

Length, 54 mm. Calical diameters, 8 mm. by 28 mm.

Locality.—5.

Material.—Specimens studied: one. This specimen, which carried no number, is in the systematic collections of the U. S. National Museum.

Remarks.—The writer knows of no other coral like this. It combines features of *Triplophyllites* and *Hapsiphyllum* but cannot be referred to either genus as now defined.

LOCALITY LIST

Information as to localities and stratigraphy of specimens not collected by the writer is given as it appeared on the labels. The writer's interpretation of the stratigraphy for all localities is given in terms of present usage in brackets. For pertinent discussions of the vicissitudes of stratigraphic usage see Cumings, 1922; Stockdale, 1929; and Stockdale, 1939.

1. Colesburg, Kentucky. Warsaw beds. [Muldraugh formation—upper Harrodsburg limestone.]

2. Colesburg, Kentucky. Warsaw-Somerset beds. [Muldraugh formation—base of Salem limestone.]
3. West Point, Kentucky. Salem (Spergen) limestone. (One label reads "Keok. group.") [Salem limestone.]
4. Edwardsville, Indiana. Warsaw stage. [Edwardsville division—upper Harrodsburg limestone.]
5. Lanesville, Indiana. Salem (Spergen) limestone. [Salem limestone.]
6. Spergen Hill, Indiana. Salem (Spergen) limestone. [Salem limestone.]
7. Abandoned quarry 0.2 mi. east of bridge over creek 2.4 mi. north of intersection of 5th and M Streets, Bedford, Indiana. (NE $\frac{1}{4}$, NW $\frac{1}{4}$, sec. 2, T. 5 N., R. 1 W.) [Base of lower Harrodsburg limestone.]
8. Road cut about 4′ high on north side of highway 62, between two quarries and bridge over Little Indian Creek, about 1.9 mi. W. of the west edge of Lanesville, Indiana. SE $\frac{1}{4}$, sec. 25, T. 3 S., R. 4 E. [Near top of upper Harrodsburg limestone.]
9. Clarksville, Tennessee. Warsaw. 10–20′ level. [Warsaw formation?]
10. Clarksville, Tennessee. Warsaw, 25–30′ level. [Warsaw formation?]
11. Lawrence Co., Indiana [Salem limestone?]
12. Warsaw formation, St. Louis stage, Mississippian period. Georgetown and Lanesville, Harrison Co., Indiana. [Salem limestone.]
13. Warsaw formation, St. Louis stage, Mississippian period. Lanesville, Harrison Co., Indiana. [Salem limestone.]
14. Warsaw beds. Near Columbia, Monroe Co., Illinois. [Warsaw formation.]
15. Keokuk limestone, Bentonsport, Iowa. [Keokuk limestone.]
16. Maynes Creek member of the Hampton formation. Quarry, Marshall Co., Iowa. [Maynes Creek member.]
17. Base of Burlington limestone, Burlington, Iowa. [Burlington limestone.]
18. Keokuk group, Colesburg, Kentucky. [Borden group.]
19. Lanesville, Spergen Hill, and Georgetown, Indiana. Warsaw formation, St. Louis stage, Mississippian period. [Salem limestone.]
20. Fort Payne chert. Florence, Lauderdale Co., Alabama. [Fort Payne formation.]
21. Warsaw. First R.R. bridge S. of Colesburg, Kentucky. [Muldraugh formation.]
22. Kinderhook group. Burlington, Iowa. [Kinderhook group and possibly lowest Osage group.]
23. Fifth division of the Burlington limestone of Rowley's classification, Louisiana, Mo. [Probably the base of the upper Burlington limestone.]
24. Fourth lower Burlington division of Rowley's classification, Louisiana, Mo. [Top of the lower Burlington limestone.]
25. West face of easternmost of two quarries on Highway 62 about 6.5 miles east of intersection of Chestnut and Market Streets in Corydon, Indiana. [Basal 10 feet of Salem limestone.]

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Butts, C., 1918, Mississippian formations of western Kentucky: Kentucky Geol. Survey (1917).

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