Otter Creek Coral Bed and Its Fauna, East-Central Kentucky

By GEORGE C. SIMMONS *and* WILLIAM A. OLIVER, JR.

CONTRIBUTIONS TO STRATIGRAPHY

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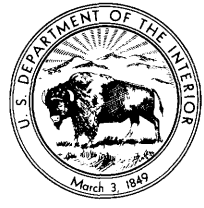

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OTTER CREEK CORAL BED AND ITS FAUNA, EAST-CENTRAL KENTUCKY

By GEORGE C. SIMMONS and WILLIAM A. OLIVER, JR.

ABSTRACT

The Otter Creek coral bed is a gray medium-grained limestone of Late Ordovician (Richmond) age on the east flank of the Cincinnati arch in Kentucky. The coral bed is lithologically transitional with the grayish-green fine-grained muddy dolomite of the underlying Rowland Member of the Drakes Formation, and is intercalated with and conformably overlain by dark-yellowish-orange fine- to coarse-grained dolomite of the Preachersville Member of the same formation. Where present, the Otter Creek is considered the basal unit of the Preachersville.

The most abundant fossils in the Otter Creek coral bed are the corals *Calapoecia huronensis*, *Foerstephyllum vacuum*, *Grewingkia rustica*, and *Tetradium approximatum*. The stromatoporoid *Aulacera cylindrica* and brachiopods of the genera *Hebertella* and *Platystrophia* also are common. These fossils and others are widespread in these beds on the east side of the Cincinnati arch and were identified in seven collections from the Richmond North, Union City, Palmer, and Lancaster quadrangles, Kentucky. Upper Ordovician coral beds containing similar faunas occur on the west side of the Cincinnati arch, but their relation to the Otter Creek coral bed is uncertain. Systematic annotations of the corals and stromatoporoids in the Otter Creek coral bed are included.

INTRODUCTION

The Otter Creek coral bed is a useful stratigraphic marker at the base of the Preachersville Member of the Drakes Formation (Upper Ordovician); it separates the Preachersville from the underlying Rowland Member of the Drakes Formation in parts of southeast-central Kentucky (Weir and others, 1965, p. 18). The Otter Creek is stratigraphically important because it contains the only well-preserved fauna that has been recognized in the Drakes Formation on the east side of the Cincinnati arch, and because it is one of several similar beds in Upper Ordovician rocks of the Kentucky-Ohio-Indiana region. The Otter Creek coral bed has been mapped in the Richmond North, Union City, and Palmer quadrangles (unpub. data) as part of the U.S. Geological Survey mapping program in

cooperation with the Kentucky Geological Survey. Seven fossil collections (fig. 1), six from these three quadrangles and one from the nearby Lancaster quadrangle, provide a basis for comparing the Otter Creek with other coral beds of similar age.

The field observations and collections were made by Simmons, except for collection USGS 4662–CO, which was made by G. W. Weir. The identification and study of corals and stromatoporoids were made by Oliver.

STRATIGRAPHIC RELATIONS AND LITHOLOGY

The Drakes Formation comprises the uppermost Ordovician strata in the area studied. It is conformably overlain by the Brassfield

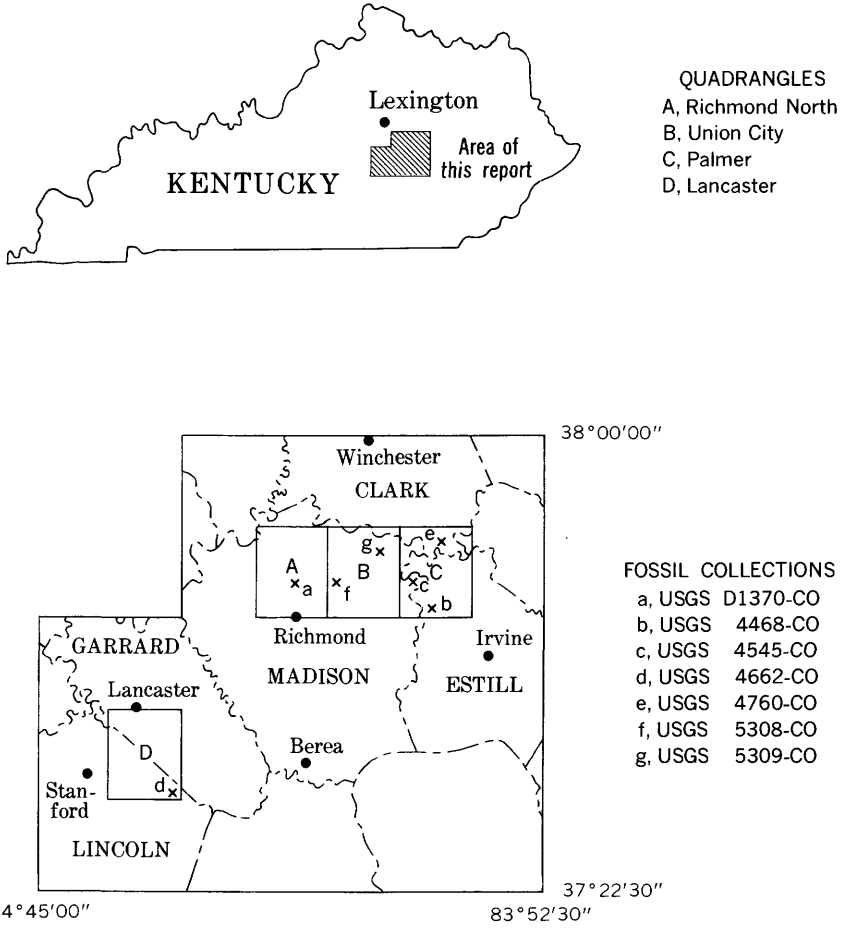

FIGURE 1.—Location of sites from which fossils were collected from the Otter Creek coral bed.

Dolomite (Lower Silurian) and conformably overlies and is transitional with the Reba Member of the Ashlock Formation (Upper Ordovician). The Drakes ranges in thickness from 130 to 160 feet and is divided into two members: the Preachersville (upper) and the Rowland (lower). The Preachersville ranges from 75 to 100 feet in thickness, and the Rowland, from 45 to 60 feet. The nomenclature used here is that of Weir, Greene, and Simmons (1965); it is compared with previous nomenclature in figure 2.

The Rowland Member constitutes grayish-green fine-grained muddy dolomite that grades into and is interbedded with dolomitic mudstone. It is 45–75 percent dolomite and 25–55 percent clay and silt. The rocks commonly are laminated to thin bedded; weathered outcrops yield fragments ranging from thin plates 0.04 inch thick to blocky pieces an inch or two thick.

The Preachersville Member is chiefly composed of grayish-green fine-grained muddy dolomite and dolomitic mudstone similar to those rocks in the Rowland Member. However, the Preachersville contains about 20 percent (field estimate) fine- to coarse-grained calcitic dolo-

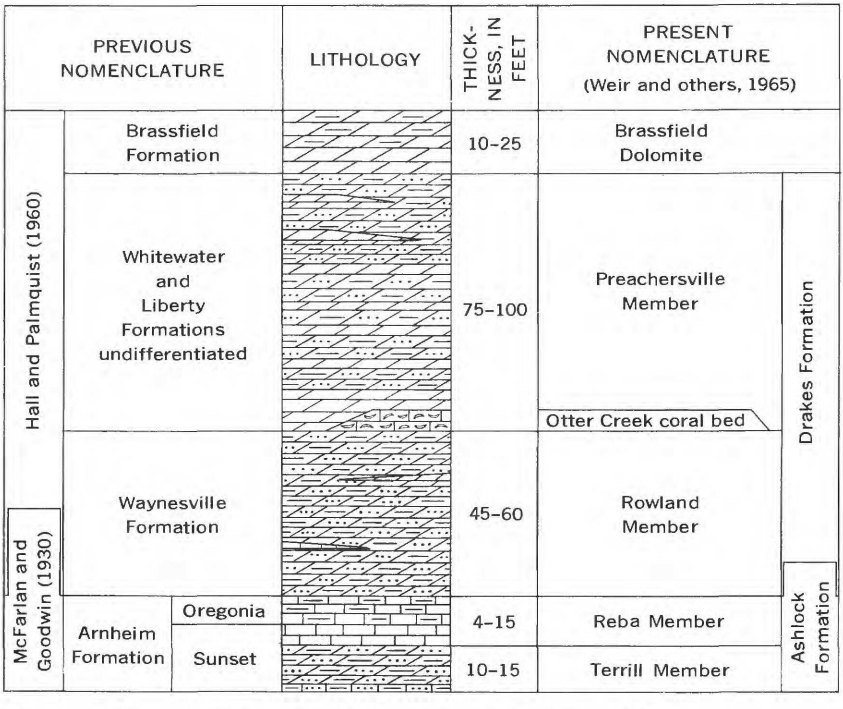

FIGURE 2.—Comparison of previous and present stratigraphic nomenclature in southeast-central Kentucky.

mite. This calcitic dolomite is gray in fresh exposures and weathers dark yellowish orange. Most beds of calcitic dolomite are 0.1–0.5 foot thick, but some are as much as 2 feet thick. These beds are everywhere abundant in the lower part of the Preachersville, and they occur so closely spaced near the base of the member that they form a ledge at most places. The contact between the Rowland and the Preachersville is mapped at the base of this ledge where the Otter Creek coral bed is absent.

The Otter Creek coral bed is a medium-light-gray limestone which weathers light olive gray to medium gray. Most of the limestone is medium grained, although fine- and coarse-grained varieties are common. Colonial corals, other fossils, and fossile fragments are abundant. Inclusions of yellowish-green clay, some as much as 0.1 inch long, are also abundant; specks of pyrite are less common. Bedding varies from thin laminations to layers more than 1 foot thick. The coral bed has a sporadic distribution and ranges in thickness from 0 to 8 feet. In many places where it is more than 3 feet

FIGURE 3.—Outcrop of the Otter Creek coral bed along a small tributary to East Fork Otter Creek in the Union City quadrangle, Kentucky. A large colonial coral is weathering out of the limestone bed adjacent to the pick. Two smaller corals that weathered free are by the pencil in the foreground.

thick, the coral bed crops out as a small ledge (fig. 3), but more commonly it is thinner (2–3 ft thick) and is marked by a band of colonial corals in the residuum and by corals and limestone colluvium downslope from the bed (fig. 4).

Where present, the Otter Creek coral bed is the basal unit of the Preachersville Member. At many places the contact of the coral bed with overlying dolomite is abrupt, but at others, limestone of the coral bed is intercalated in 1-inch-thick beds with dark-yellowish-orange dolomite through a vertical interval of as much as 6 inches. The coral bed is transitional with the Rowland Member through a thickness of a few inches to as much as 3 feet. Where the transition zone is thin it is marked by an abrupt compositional change from dolomite below to limestone above. Where the zone is thick the transition is one of alternating 1-inch-thick beds of shaly grayish-green dolomite-rich beds and pale-grayish-green lime-rich beds. The contact is placed so that the transitonal beds are included in the Otter Creek coral bed; thus, all fossiliferous layers are in the Otter Creek. Transitional lithologies are also common near the margins of the Otter Creek coral bed where it wedges out.

FIGURE 4.—Band of colonial corals weathered out of the Otter Creek coral bed near East Fork Otter Creek in the Union City quadrangle, Kentucky. Limestone fragments and corals are in the colluvium downslope.

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FAUNA

The most abundant fossils in the Otter Creek coral bed are the corals *Calapoecia huronensis*, *Foerstephyllum vacuum*, *Grewingkia rustica*, and *Tetradium approximatum*. These corals are present at most places where the Otter Creek crops out. The cylindrical stromatoporoid *Aulacera cylindrica* and brachiopods belonging to the genera *Hebertella* and *Platystrophia* are also common.

The collections listed in table 1 were made with the intention of obtaining a large overall sample, particularly of corals and stromatoporoids. The number of specimens of each species collected for study from each locality is indicated, but it is an index of abundance in only a general way. The table clearly indicates that some species are more common than others, but relative and actual numbers of specimens collected at each locality are a function of overall collection size and collecting bias. Collection D1370–CO is more objective than the others as it preceded any paleontologic identifications and is larger. In making the later, smaller collections (higher numbers), the intention was to obtain variety rather than proportional numbers.

Coral beds of Richmond age on the west side of the Cincinnati arch have been extensively described, most recently by Browne (1964, 1965), who also reviewed previous work. Browne concluded that four coral zones occur in formations of Richmond age: one in the Waynes-

TABLE 1.—*Number of specimens of each species of coral and stromatoporoid identified in the Otter Creek coral bed*

[Identifications by W. A. Oliver, Jr.]

	USGS collection							Total
	4662–CO	D1370–CO	5309–CO	5308–CO	4468–CO	4545–CO	4760–CO	
Stromatoporoids								
Aulacera cylindrica (Foerste)	4	22	3	6	7	1	4	47
Labechia huronensis (Billings)	-----	-----	-----	3	1	-----	-----	4
Solitary corals								
Grewingkia rustica (Billings)	1	15	-----	-----	4	?	2	22
"Streptelasma" sp. A	1	-----	-----	-----	-----	-----	1	2
"S." sp. B	-----	-----	-----	-----	1	-----	2	3
"S." sp. C	-----	3	-----	-----	-----	1	-----	4
"S." sp. D	-----	3	-----	1	5	2	1	12
"S." sp. E	1	5	-----	-----	1	3	-----	10
"S." angulatum (Billings)	1	-----	-----	-----	-----	-----	-----	1
Colonial corals								
Calapoecia huronensis Billings	2	3	2	7	7	1	2	24
Favistina stellata (Hall)	2	-----	-----	-----	-----	-----	-----	2
Foerstephyllum vacuum (Foerste)	3	11	6	11	4	-----	-----	35
Soffordophyllum floweri Browne	2	-----	-----	-----	-----	-----	-----	2
Tetradium approximatum Bassler	2	10	2	4	4	9	8	39
Total specimens	19	72	13	32	34	17	20	207

ville, two in the Liberty, and one in the Whitewater Formation (Browne, 1964, p. 385; 1965, p. 1180–1181). Browne (1965) summarized the distribution of corals and described the colonial corals except for *Tetradium*. This recent work, based on Kentucky sections west of the Cincinnati arch, provides a standard with which the Otter Creek coral bed on the southeast side of the arch can be compared.

Foerste (1912, p. 19–22) was the first to recognize (near Richmond, Ky.) what is here called the Otter Creek coral bed. Foerste considered the corals equivalent to his Bardstown coral reef at the base of the "Liberty bed" near Bardstown, Ky., on the west side of the Cincinnati arch.

The coral bed has been traced by geologic mapping across the adjacent Richmond North, Union City, and Palmer quadrangles, so collections from these areas are considered a single fauna. The Otter Creek coral bed is the source of all collections listed in table 1 except 4662, which is from the Lancaster quadrangle, 20 miles southwest of the other quadrangles. The bed has not been traced from the other quadrangles into the Lancaster quadrangle, and collection 4662 may represent another coral bed at a different horizon within the Preachersville Member of the Drakes Formation.

So restricted, the coral fauna can be compared with Browne's beds 3 and 4, upper Liberty bed, and Whitewater bed, respectively. Of the Otter Creek species, *Foerstephyllum vacuum* ("subsp." *vacuum* and *magnum*) and *Calapoecia huronensis* characterize Browne's beds 3 and 4. Bed 4, however, also includes *Favistina stellata* and *Safordophyllum floweri*, so that if collection 4662 is included, the Otter Creek fauna most closely resembles that of Browne's Whitewater coral bed.

The ranges given by Browne (1964), p. 387; 1965, p. 1179) indicate that the species content of the beds cannot be used for detailed correlation, as many species range through coral beds in which they do not occur. It is likely that if coral-bed environments existed somewhat earlier or later than known coral beds, their species composition would have been similar to that of the known beds. Therefore, the general similarity in species content of the Otter Creek coral bed and of Browne's beds 3 and 4 suggests that these beds are of the same general age but not necessarily contemporaneous. Richmond coral biostratigraphy will have to be known in much greater detail before detailed correlations will be practical.

Table 2 lists fossils other than corals and stromatoporoids that have been identified from the Otter Creek coral bed. No attempt was made to obtain a comprehensive collection at any of the localities, and the identifications cannot be used as a basis for comparing one collection with another.

TABLE 2.—*Fossils other than corals and stromatoporoids identified in the Otter Creek coral bed*

[Identifications: bryozoans by O. L. Karklins; brachiopods in collection D1370-CO by R. J. Ross, Jr; other brachiopods by R. B. Neuman; gastropods by E. L. Yochelson; pelecypods by John Pojeta, Jr.]

	USGS collection						
	4662–CO	D1370–CO	5309–CO	5308–CO	4468–CO	4545–CO	4760–CO
Bryozoans							
Heterotrypa subramosa (Ulrich)							×
H. sp. form e					×		
Stigmatella? sp					×		
Constellaria sp		×					
Amplexopora sp					×		
Hallopora sp. form c–3		×					
Homotrypa ramulosa Bassler							×
H. sp					×		
Gortanipora(?) sp. form c		×					
Homotrypid new genus 3		×					
Brachiopods							
Hebertella occidentalis (Hall)							×
H. sp. cf. *H. sinuata* (Hall)		×				×	
H. sp	×		×	×	×	×	
Lepidocyclus capax (Conrad)					×		
Plaesiomys subquadrata (Hall)					×		
Platystrophia annieana McEwan		×	×	×	×		
P. attenuata McEwan	×						
P. sp. cf. *P. clarksvillensis* Foerste					×		
P. sp. cf. *P. cypha* var. *arcta* McEwan		×					
P. foerstei var. *ampla* McEwan		×					
P. sp		×				×	×
Rafinesquina sp		×			×	×	
Strophomena sp		×			×		
Zygospira kentuckiensis James							×
Z. sp. (small)		×					
Gastropods							
Bellerophontacean indet. cf. *Tropidodiscus*					×		
Liospira sp. aff. *L. micula* (Hall)		×	×	×			
L. sp. indet					×		
Loxoplocus (*Lophospira*) *bowdeni* (Safford)				×			
Murchisonia? sp. indet					×		
High-spired gastropod indet. cf. *Murchisonia*			×				
Pelecypods							
Ctenodonta sp					×		
Pterinea sp. indet		×					

SYSTEMATIC ANNOTATIONS

Although much systematic work has been done on the Richmond corals, a number of uncertainties remain, and several taxa have not yet been described or analyzed by modern methods. The Otter Creek collections are not large enough for redescription or revision, but their study has produced some data and conclusions that may be of value to other workers. The basis for the identifications in table 1, references to illustrations, and annotations are included in the following paragraphs for those who wish to use this as a field guide.

STROMATOPOROIDS

1. *Aulacera cylindrica* (Foerste). Specimens apparently referable to the nominal species *A. cylindrica* and *A. plummeri* as well as to one or two nodulose "species" are present in the collection. Variation in internal and external morphology is extreme, and intermediates between all forms are included. At present it is impractical to recognize more than one species in the Otter Creek collections, and the senior name among those available has been chosen for the present purpose.

Study of larger collections and comparison with material from other Cincinnati arch areas is desirable. The present identification is based on descriptions and illustrations in Galloway and St. Jean (1961, p. 21–39 and pls. 3–5, 12).

Aulacera cylindrica fragments are easily recognized by their cylindrical form and coarsely cystose axial zone with surrounding concentric structure. Diameters in the 47 specimens studied range from 1 to 5 cm; lengths are as much as 8 cm.

2. *Labechia huronensis* (Billings), as described by Galloway and St. Jean (1961, p. 50–53 and pl. 7), is the only massive stromatoporoid in the Otter Creek collections. The largest of four specimens has a maximum dimension of 15 cm.

SOLITARY (HORN) CORALS

3. *Grewingkia rustica* (Billings). This is the common large horn coral of Richmond age in the Cincinnati arch area. Coral bed specimens are as large as 40 mm in diameter and 8 cm in length. Twenty-two specimens were examined and compared with specimens from other Kentucky, Indiana, and Ohio collections.

This species is commonly referred to as *G. rustica* or *Streptelasma rusticum* in the literature concerning the Cincinnati area. However, the original material on which the name was based is from Snake Island, Lake St. John, Quebec, and may not be of the same age

(Flower, 1961, p. 18, 86). The types should be restudied to determine if the name is applicable to the Kentucky-Ohio-Indiana species. Topotype specimens illustrated by Stumm (1963, pl. 2, figs. 8–10) are similar to the Kentucky forms.

4. "*Streptelasma*" spp. Thirty-two small horn corals are in the Otter Creek collections. If the Richmond horn coral classification were to be thoroughly revised, some of these would certainly be referable to named species, but others may be early stages of *G. rustica*. At present, the designations *Streptelasma* sp. A to E refer to morphologic types, the systematic importance of which is unknown. Comparison of these types with specimens in other collections shows that some of the forms are present in the Liberty and Whitewater Formations near Richmond and Liberty, Ind., in the Whitewater Formation near Oxford, Ohio, and at several localities on both sides of the Cincinnati arch in Kentucky.

5. "*Streptelasma*" *angulatum* (Billings). The identification of a single specimen is based on external form only. Study of abundant material might show this to be an early stage of another species.

COLONIAL CORALS

6. *Calapoecia huronensis* Billings. Twenty-four specimens of *Calapoecia* from the Otter Creek collections are variable, but all are assignable to this one species. This is a senior synonym of *C. cribriformis* as used by Foerste and others in the pre-1950 literature.

Colonies are massive and as large as 21 cm in maximum diameter; corallite diameters average 3–4 mm. Weathered surfaces show the porous wall, so that specimens can commonly be generically identified in the field.

The species was recently redescribed and illustrated by Browne (1965, p. 1184–1185 and pls. 147, 152).

7. *Favistina stellata* (Hall). Two fragments of *Favistina* from locality 4662 are the only specimens of this species in the collections. They were identified by their large corallites (5–6 mm) and long septa. The presence of long septa distinguishes these forms from *Foerstephyllum vacuum*, which is otherwise similar in appearance.

Flower (1961, p. 76–81) and Browne (1965, p. 1186) discussed the involved nomenclatorial problems of this genus and species. Browne considered the genus *Favistina* Flower (=*Favistella* of authors) to be a junior synonym of *Cyathophylloides*. Our knowledge of this genus and its type species is so limited, however, that it seems best to utilize *Favistina* Flower, which has a known, well-described type species, until adequate data on other possible genera are available.

The Otter Creek specimens have been compared with the lectotype

of the species (selected by Browne, 1965, p. 1186) and with many specimens from other localities. Richmond *Favistina* have recently been illustrated by Flower (1961, pls. 38–40) and by Browne (1965, pls. 147–149, 151, 152).

8. *Foerstephyllum vacuum* (Foerste). This species is referred to as *Columnaria vacua* in the pre-1950 literature. Colonies are massive; 35 Otter Creek specimens range from 1 to 19 cm in maximum diameter. Average corallite size in colonies ranges from 3 to 5 mm or more. This species differs from *Favistina stellata* by having no septa, or very short ones; locally these may be amplexoid, extending nearly to the axis on the upper surfaces of tabulae.

Browne (1965, p. 1182–1183, pls. 146, 152) recognized *F. vacuum* and *F. vacuum magnum* from the coral beds west of the Cincinnati arch, the two taxa being associated in most of her collections. Browne's specimens were compared with those from the Otter Creek, and the typical "subspecies" and "subspecies" *magnum* occur in at least two of the collections. Browne's subspecies are here interpreted as extremes in a morphologically variable species.

9. *Saffordophyllum floweri* Browne. Two specimens from locality 4662 have been compared with Browne's types (Browne, 1965, p. 1183–1184 and pls. 146, 151) and are certainly conspecific. The species is massive and compact and has corallites approximately 2 mm in diameter. The larger colony from locality 4662 has long and short diameters of 16 and 8 cm, respectively, and a height of 5.5 cm. In hand specimen, *S. floweri* can be confused with *Calapoecia huronensis*, but the latter has a porous wall.

10. *Tetradium approximatum* Bassler. This species is commonly ascribed to Ulrich, although the name had no status until Bassler (1915, p. 1264–1265) listed descriptions and illustrations of specimens that he considered to belong to this species. Ulrich gave no information on the species except its general stratigraphic position, so the 1915 species concept is that of Bassler, not Ulrich. James (1940, p. 645) apparently designated as lectotype the specimen illustrated by Foerste (1909, pl. 10, fig. 1a–1b) as *Tetradium minus*. As the lectotype has not been reexamined, the propriety of the present name assignment is uncertain. Foerste (1916), followed by Bassler (1950), considered *Tetradium ontario* Hall (1884) to be a senior synonym of *T. approximatum*, but as *T. ontario* is from New York and the types are not available for study, this does not help to stabilize matters. However, a distinct *Tetradium* is present in beds of Richmond age in the Cincinnati arch area, and it would best be termed *T. approximatum*, its most familiar name, until such time as adequate search can be made for the necessary specimens.

T. approximatum is massive. Thirty-nine Otter Creek colonies vary in size; the largest has a maximum diameter of 20 by 16 cm and a maximum height of 9 cm. Individual corallites are less than 1 mm in diameter; the typical four septa are short and weakly developed in most sections. The most recent description and illustration of *T. approximatum* were given by Bassler (1950, p. 290 and pl. 3, figs. 8–13, as *T. ontario*).

FOSSIL LOCALITIES

Fossil collection localities are listed below according to U.S. Geological Survey fossil-collection numbers and are located by quadrangle, coordinates, and altitude. All fossils are in the collections of the U.S. Geological Survey. The coordinates given for each collection are measured from the 10,000-foot grids based on the Kentucky coordinate system, indicated on the sides of the topographic maps. Three of the quadrangles lie within two overlapping coordinate zones, and locations are given according to both zones, in figures that are rounded off to the nearest 50 feet. Altitudes given are accurate to within 10 feet.

USGS D1370–CO; Richmond North quadrangle; 1 985 050, 108 350 (North); 2 418 800, 536 550 (South); altitude, 845 feet.

USGS 4468–CO; Palmer quadrangle; 2 049 600, 91 600 (North); 2 483 300, 520 350 (South); altitude, 630 feet.

USGS 4545–CO; Palmer quadrangle; 2 045 550, 113 400 (North); 2 479 250, 542 200 (South); altitude, 665 feet.

USGS 4662–CO; Lancaster quadrangle; 2 358 400, 427 300; altitude, 900 feet.

USGS 4760–CO; Palmer quadrangle; 2 057 900, 130 450 (North); 2 490 850, 559 800 (South); altitude, 625 feet.

USGS 5308–CO; Union City quadrangle; 2 032 150, 125 650 (North); 2 459 200, 554 400 (South); altitude, 740 feet.

USGS 5309–CO; Union City quadrangle; 2 007 600, 111 050 (North); 2 441 250, 539 250 (South); altitude, 850 feet.

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