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CORALS FROM THE REDWALL LIMESTONE (MISSISSIPPIAN) OF ARIZONA

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INTRODUCTION

It is becoming increasingly necessary that the fauna of the Redwall limestone be adequately known. Within the past three years extensive exploration has been undertaken by numerous oil companies in the Great Basin of Utah, Nevada, and California. Much of this work centers about strata of Carboniferous age, but not enough has been published on western formations to enable accurate correlations to be made very often. For instance, the exact relationships between the Madison limestone (which produces oil in the Rocky Mountains), the Redwall limestone of Arizona, and Monte Cristo formation of Nevada and California are still unknown although the three formations are known to be about the same age. This paper presents the stratigraphic distribution of corals in the Redwall limestone so that better correlations can be made with it.

Corals upon which this study is based were collected by R. C. Gutschick on various field trips during 1941 and 1949 while he investigated the Redwall limestone of Arizona. An abstract covering preliminary results was published in 1942. Mr. Gutschick presented this paper orally before the Paleontological Society at the annual meeting in Boston in November, 1952.

Although the Redwall limestone, due to its prominent outcrop in the Grand Canyon, is one of the most well known formations in North America, very little has been published about it. Obviously, its precipitous topographic expression has prevented careful study, except at rare places, in the Grand Canyon. In addition, however, the formation is not very fossiliferous in the canyon. Most of the field work involved in the present paper was done south of Grand Canyon in the Jerome mining region where the formation is relatively accessible and fossiliferous.

Corals are unusually useful in stratigraphic investigations of Paleozoic rocks in many regions. They are husky enough to withstand considerable physical weathering or abrasion and commonly retain their specifically identifiable characters even in regions where thinner fossils are obliterated by replacement or alteration. Corals from the Redwall limestone are generally well preserved, even in rocks which have been extensively recrystallized.

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Gutschick's study (1942) of the fauna of the Redwall limestone is the most detailed account of it yet to be published. Heretofore only sketchy faunal lists have been published and these are somewhat contradictory. When Gilbert named the Redwall limestone in 1875 he mentioned "coralline" or "coralloid mottlings." The first coral identified from the Redwall limestone was *Menophyllum excavatum* by Girty (in Lee) in 1908. Girty was quoted by Ransome in 1910 as authority for identifying two species of corals from the Redwall limestone. Other writers have contributed similar notes through the years until about half a dozen species have been noted from either this formation or its supposed equivalents in Arizona (Modoc limestone, Tornado limestone, Escabrosa limestone, and "Carboniferous limestone").

STRATIGRAPHY[1]

INTRODUCTION. — The Redwall limestone is generally a cliff-forming carbonate unit throughout the canyon country of northern Arizona. Although the entire formation is continuously and conspicuously exposed for several hundred miles throughout the Grand Canyon, there are few places indeed where it can be examined. As a result the formation has been studied in detail where it is accessible along the southwest margin of the Colorado Plateau from the East Verde River crossing between the towns of Pine and Payson northwestward to Picacho Butte some 12 miles southeast of Seligman. In this traverse the thickness increases from less than 50 feet to approximately 300 feet respectively. McKee, 1951, has published an isopach map for the Mississippian of Arizona. This covers the area of Fossil Creek, Mingus Mountain including Jerome, Sycamore Canyon, and the Black Mesa northeast of Chino Valley. Within this area recognizable lithologic units were determined; however, until their total areal extent can be traced, numbers rather than names have been assigned to the individual units referred to as members. Other sections outside this area were examined and some collections made so that the corals from these places have been included in this study. The locality list and text-figure 1 indicate the distribution of the fossil corals.

DEVONIAN-MISSISSIPPIAN UNCONFORMITY. — The Redwall limestone rests unconformably upon the Jerome formation and Island Mesa beds (Stoyanow, 1936) of late Devonian age. The exact position of this contact is not always discernible either physically or faunally since the lowest member of the Redwall contains re-worked Devonian residual material giving it a Devonian appearance and the beds are virtually unfossiliferous. Where it has been recognized, basal conglomerates and wavy, irregular, thin-bedded dolomite rocks are found associated with red, hematitic, discontinuous shale.

[1]This section is the responsibility of the junior author.

MEMBER I. — Member I consists of transitional Devonian-Mississippian lithologies in its lower part and a distinctive, uniform, carbonate zone in its upper part. The lower beds are obviously reworked regolithic Devonian materials which resemble the upper Devonian lithologies in being light-gray tinged pink and lavender finely-crystalline dolomites, fine-grained limestones, and local thin quartz sandstones. The beds in the lower part of the member are usually thin but increase in thickness upward from a few inches to several feet. A few layers of limestone in the middle of these transitional beds contain gray chert nodules. The thickness of the transitional beds varies from 18 to 40 feet averaging approximately 25 feet. With the exception of crinoid stems, no other fossils have been found in these rocks.

The upper zone of this member is one of the most distinctive, consistent, lithologic units of the entire formation. It consists of white to very light-gray, semi-crystalline, partly oolitic, thick-bedded limestone. From a distance the light color of this unit stands out between darker colored rocks. It makes a strikingly conspicuous, narrow, horizontal band along the margin of the Colorado Plateau. The topmost bed is coarsely-crystalline, crinoidal, fossiliferous limestone which contains abundant cup corals but they must be extracted from the matrix by crushing large blocks of rock.

There is an unconformity at the top of Member I which cuts out the upper part to the north and northwest so that in the Grand Canyon area the distinctive unit is not recognized.

MEMBER II. — This rock unit differs lithologically from the others by its high content of chert. In the Black Mesa region north of Chino Valley it is light-gray, slightly-pinkish, fine-grained, porous, cherty limestone. The white to light-gray fossiliferous chert occurs in nodules which develop into layers of large, flat, nodular chert in the upper part of the member. The porosity in the limestone matrix is the result of differential solution of tiny crinoid stems. Southeastward the limestone has not been affected by solution so it is grayish-white, crystalline, crinoidal, and continues to have the cherty layers. Overlying beds lack the chert, so that the contact between Members II and III is rather sharp. Although fossils are not common in this member, a few corals have been collected and are described. The thickness of the member varies from 50 to 100 feet.

MEMBER III. — This unit is characterized by uniform composition, texture, and massive expression. It represents the massive, monolithic, coarsely-crystalline, crinoidal, thick-bedded, fossiliferous, relatively pure limestone of the formation. Fossils are abundant but preservation is not particularly good. There is no differential resistance between fossil and matrix which makes it necessary to break them out of fresh rock to obtain better specimens. Corals are very common in this member yet there is little diversity of forms.

In the Jerome-Sycamore Canyon-Black Mesa area, there is a peculiar blanket layer of cobble — to boulder-size solution limestone rubble which has much red silty material between the clasts. In Sycamore Canyon there is as much as 15 feet of solution breccia. The presence of this residual deposit implies the existence of unconformity between Members III and IV.

MEMBER IV. — Member IV consists of gray fine-grained to dense limestones that are partly crystalline in the lower part, cherty in the middle, and micro-oolitic or pellety in the upper part. With the exception of a prominent horn coral zone near the top and a molluscan fauna in the cherts of the middle, fossils are few and scattered in the remainder of the member. The compactness and dense texture gives the rock of this member a metallic ring, especially that of the upper part. The thickness ranges from 60 to 75 feet.

In the Jerome area the chert weathers a rusty-brown and contains many fossils preserved as molds. The fossils are chiefly mollusks, although corals, brachiopods, and other forms are also present.

REDWALL-SUPAI RELATIONSHIPS. — In Gila County southeast of Pine, Arizona, pre-Pennsylvanian channeling has removed the upper part of the Redwall, and the Naco formation (Pennsylvanian) rests unconformably on it with over 25 feet of relief along the contact (Huddle and Dobrovolny, 1952). Members III and IV are missing and all that remains of Member II in places is a skeletal rubble of residual limestone blocks. Northwestward at Fossil Creek the Naco formation rests on Member IV. From Fossil Creek to Jerome the relationship between the Naco formation and the lower Supai formation is obscure due to lack of outcrops. At Jerome and northwestward to Peach Springs, fossils have not been found in the lower Supai formation, therefore precise correlation of these rocks (Hughes, 1952; McNair, 1951) has not been possible.

The Redwall limestone generally erodes into cliffs with the upper part making a bench. Soft reddish shales of the overlying lower Supai formation are weak and form slopes. Locally a conglomerate consisting of dark-gray to yellowish and purple-red, fine-grained to dense limestone pebbles and cobbles along with gray chert which often weathers rust-colored is found in depressions on the Redwall surface. This conglomerate is loosely cemented and has a purplish-red silty shale matrix.

GENERAL REMARKS. — The entire fauna of the Redwall limestone presents some interesting problems which are fundamental to the understanding of western Mississippian stratigraphy. Faunal elements are represented by brachiopods, corals (cup, horn, and colonial), crinoids (mainly fragmental with calices uncommon), cephalopods (principally nautiloids), foraminifers, bryozoans, snails, clams, fishes (teeth and spines), blastoids, trilobites, ostracods, worm tubes, and echinoid fragments. Calcareous algae have also been recognized. Two obstacles which impede the progress of the paleontologic correlation are (a) lack of fossils in the more critical parts of the section; namely Members I, II, and IV, although the latter has well preserved corals near the top, and (b) the generally poor state of preservation of the better specimens.

There have been no comprehensive general paleontological reports published recently on the western Mississippian which carefully describe the complete fauna of an entire formation or group of formations. Naturally correlation has usually been made by comparing western Mississippian fossils with those of the type area in the Mississippi Valley; however, there has been no adequate understanding of the relationship of the faunas of the two areas which are separated by quite some distance. A case in point is the identification of *Spirifer centronatus* throughout the west based upon comparison of inadequately described material from Ohio; yet the chain of references to this form persists to the present. Only recently Bowsher has checked the type specimens and visited the locality from which they were collected so that clarification of the species is forthcoming.

One peculiar relationship which becomes apparent as the study progresses is that the corals and cephalopods both taken by themselves indicate a lower Mississippian (Kinderhook) age for the entire formation in the area studied from Natural Bridge to Picacho Butte, including the Redwall exposed in the laccoliths of the Flagstaff region. Some brachiopods, crinoids, and blastoids (especially from Member III) clearly suggest an Osage (Burlington) correlation for that unit. This apparent anomaly is not unlike the situation reported by Schindewolf (1928) in which the corals, brachiopods, and trilobites each suggest different correlation boundaries between Devonian and Carboniferous.

A small collection of poorly preserved fragmental nautiloid cephalopods from the chert in Member IV of the Jerome Hill section was studied by A. K. Miller et al, 1949. The cephalopods include *Triboloceras digonum* varieties *semicirculare* and *dyeri* (?) which along with others seem to indicate a Kinderhook age for the beds which contain them. This is in total agreement with the corals. Of course, not much is known about Osage cephalopods in this country so that it is possible that the above forma may have longer ranges than are now known. Diligent research has been made for goniatites and some have been found but the preservation is too poor for identification of the specimens.

Stoyanow, 1936, stated that well-preserved heads of the crinoid *Physetocrinus* have been found in the Natural Bridge area between Pine and Payson. A. L. Bowsher (personal communication) of the U. S. National Museum, where a specimen is deposited, has identified it as *Physetocrinus lobatus*. Elsewhere this species is confined to the Nunn member of the Lake Valley formation, wherein it is common in the lower part. The Nunn member is probably lower Osage (Fern Glen) age.

Stoyanow (ibid, 1936, pp. 512-513) reports that Wooddell found *Schizophoria swallovi, Spirifer rowleyi,* and *Orthotetes keokuk* in the Redwall at Jerome. Collections at hand include in addition *Spirifer grimesi, Spirifer forbesi, Pentremites,* and *Schizoblastus* (possibly *Cryptoblastus*), *Lyropora* and other less important fossils which collectively have an Osage aspect. Further study of the gross fauna is being continued (by RCG).

Zeller's preliminary work (1950) on the endothyroid foraminifera suggests that they may have stratigraphic importance for correlation. Foraminifera of this type have been found in the upper part of the Redwall north of Peach Springs. The forms are large, being similar to forms common in the Meramec of the type area; however, no systematic study of the phylogeny of the endothyroid foraminifera is available from which precise correlation of species can be made.

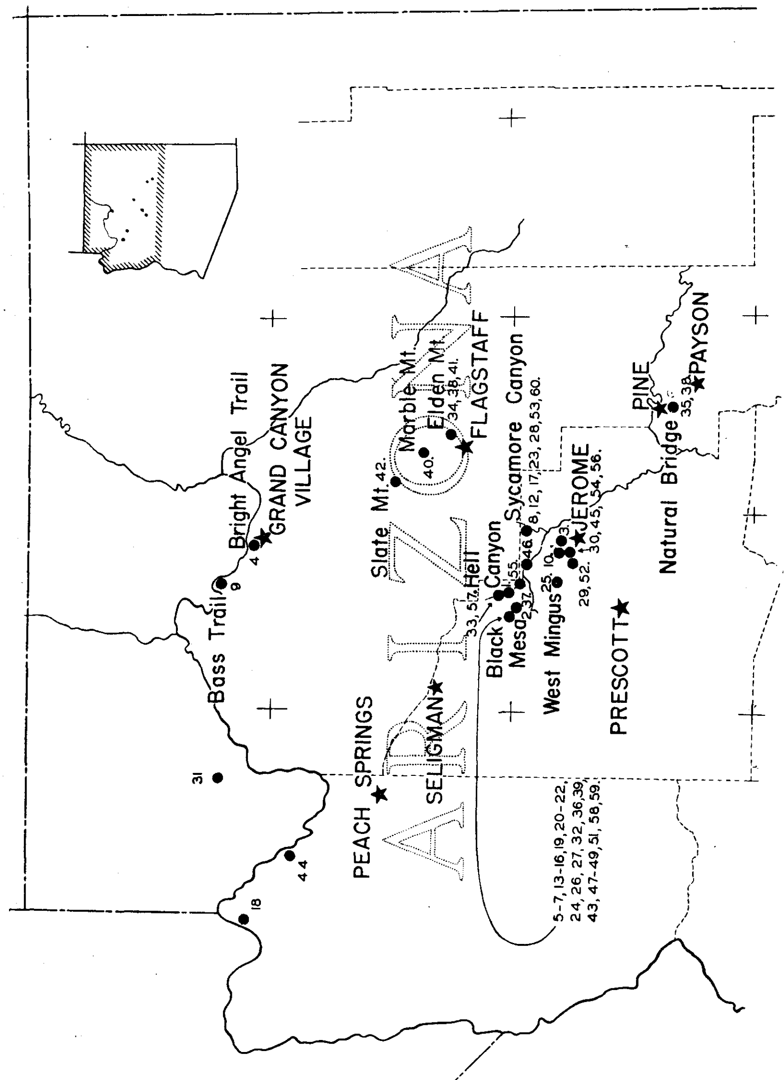
ANALYSIS OF THE FAUNA[1]

The coral fauna of the Redwall limestone largely consists of new species or of species the ranges of which are indecisive. For these reasons, the correlation of the formation on faunal methods is difficult. Vertical ranges of genera alone are too long to be significant. One must either compare evolutionary stages of species or correlate by comparing ranges of closely related forms. These latter methods are obviously prone to introduce subjective error. In as much as the correlation of strata in Arizona with those in Missouri and Illinois involves a very long distance and the intervention of diverse geological terranes, accuracy of the ultimate conclusions is accordingly reduced. Nevertheless, the conclusions stated below constitute a reasonable statement of the probable relationship of these faunas with those of the standard Mississippian section.

Triplophyllites (T.) persimilis is rather closely related to *T. cliffordanus* from the Fern Glen formation and the Chouteau limestone of the Mississippi Valley, and is even more closely related to *T. excavatus* from the Madison limestone of the Cordilleran region. This indicates an age duration of upper Kinderhookian to lower Osagian in Missouri and Illinois.

[1]This section is the responsibility of the senior author.

Text-figure 1. Location of measured sections and fossil localities.



Text Figure I

NOTE: Recent work reported upon in a preliminary way by Clark and Beveridge (1952, pp. 14, 15, 71-79) and Spreng (1952, pp. 81-86) introduces changes in our understanding of Kinderhookian-Osagean boundary problems. They use "Compton formation" instead of "Chouteau limestone" and assign the overlying Sedalia limestone to the "Chouteau group," which group they believe to be Kinderhookian. This would seemingly tend to strengthen assignment of the Redwall limestone to the Kinderhookian Series. However, renewed collecting from strata in Missouri indicates that some fossils (**T. cliffordanus, T. calceolus, V. sedaliense,** and **L. microstylum** being noteworthy) related to Redwall species are known from or are even restricted to the Pierson formation, which is assigned to the lower Osagean Series. When these current studies in Missouri are concluded and the ranges of the corals are completely known, it may be necessary to reevaluate the significance of the Redwall corals.

Triplophyllites (Homalophyllites) paucicinctus is very closely related to *T. (H.) calceolus* from the midwest, where it ranges through the Chouteau limestone (upper Kinderhookian) and Reeds Spring limestone (lower Osagian).

Caninophyllum incrassatum is mose closely related to *Vesiculophyllum sedaliense* from the Chouteau and Sedalia limestones (upper Kinderhookian and lower Osagian) of the midwest. The latter species has been reported by Stoyanow (1926, pp. 315, 320) from the "Lower Mississippian limestone" of Arizona.

Lithostrotion [Lithostrotionella] circinatus belongs to a genomorphic group of corals most commonly considered to be indicative of Meramecian age in the midwest. Nevertheless, lithostrotionlid corals (*L. microstylum*) are known in the midwest from as low as the "upper Chouteau limestone," which is probably equivalent in present-day terminology to the Sedalia limestone (lower Osagian). The Osagian lithostrotiontid corals resemble those under study in having circular columellae. This feature is not intended to warrant absolute correlation, but is mentioned to demonstrate the possibility that the Redwall corals might just as well (and, actually, more probably) be lower Osagian as Meramecian. *L. circinatus* resembles *L. microstylum* in growth habit and columellar construction.

Pleurodictyum expansum is not such a species as would lend confidence to correlations. Its presence in lower Osagian strata of the midwest is only weak substantiation of its range in distant regions. The other coralline species of the Redwall limestone are not useful in correlations as yet.

Ranges of the corals in the Redwall limestone are given in figure 2. Not very many specimens were obtained from members I and II, but such as were obtained generally range pretty well through the formation. Members III and IV have abundant coral faunas which are quite similar in basic constitution. *Triplophyllites (H.) paucicinctus* and *Caninophyllum incrassatum* are the major elements by means of which members III and IV may be recognized. Member IV also carries *Lithostrotion,* especially in its upper portion.

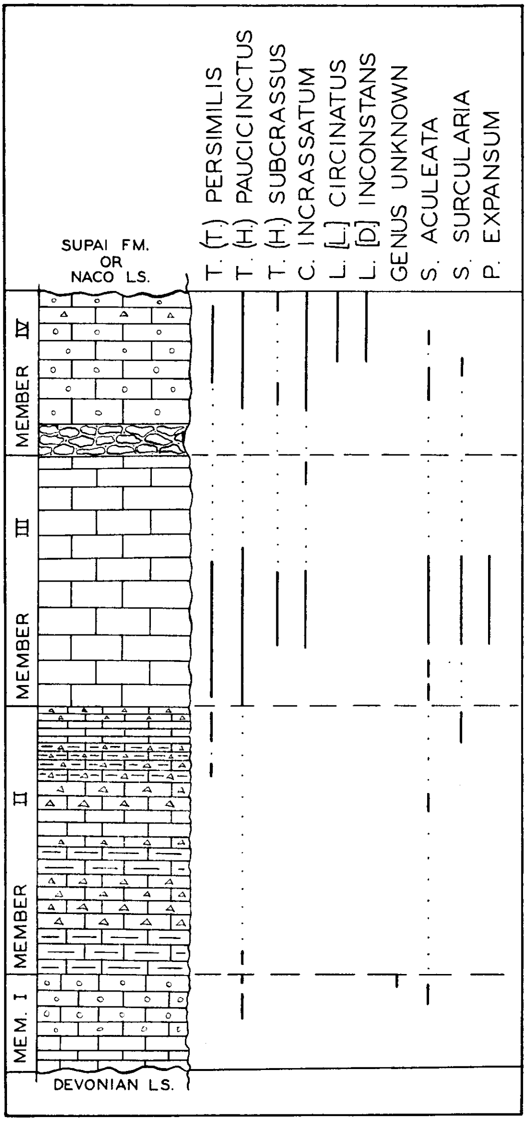
The entire Redwall limestone of the Jerome region is correlated herein on coralline faunal evidence with the Chouteau limestone and possibly with the Sedalia limestone of Missouri. In effect, then, the Redwall limestone is almost all referable to the Kinderhookian Series. If any Osagian strata be present, they are represented in the upper few feet of Member IV. The exact boundary between Kinderhookian and Osagian strata is not clearly demonstrable on the basis of known ranges of corals in the midwest, hence, the contact is not clearly established in Arizona. It is definitely known that some species range from the Kinderhookian into the Osagian, so this prevents firm separation of units just as well in Arizona as in the Mississippi River Valley.

The coral fauna of the Monte Cristo formation of Nevada has not been published yet, except in brief faunal lists by Girty (in Hewett, 1931). One notes that *Cyathophyllum,* listed by Girty, which (to the writer's knowledge) probably is the *Caninophyllum* of this paper, occurs in the Bullion, Arrowhead, and Yellowpine limestone members. The senior author has collected *Lithostrotion* and "*Cyathophyllum*" from the Yellowpine limestone member at the type locality. It seems quite probable that members III and IV are equivalent to the Bullion member and to the Arrowhead and Yellowpine members of the Monte Cristo limestone respectively. This probably will be the subject of further study by one of us (WHE).

LOCALITY LIST

Unless otherwise noted, all collections are from Yavapai County, Arizona, and were collected by R. C. Gutschick. Text-figure 1 shows the location of fossil localities.

1. Massive limestone 20-60 feet above base of member IV. From quarry 1700 feet west of bridge over Hell Canyon, ¾ mile west-southwest of Drake; S margin, S½, SE, SW, sec. 32, T. 19 N., R. 1 W., Paulden quadrangle.
2. Member IV. From Onyx mine on top of the escarpment north of Chino Valley and west of Drake.
3. Upper 15 feet of member IV. From cherty limestone at floor of west side of abandoned quarry on north side of road 1 mile northwest of Jerome; C, SE, SE, sec. 16, T. 16 N., R. 2 E., Clarkdale quadrangle.
4. Member IV. From the "very top of the Redwall cliff in the canyon of Garden Creek directly under El Tovar" (Noble, 1922, p. 56); in Grand Canyon.
5. Member IV, upper 3 feet of the Redwall limestone. From the section exposed in the erosional reentrant along the southwest-facing scarp north of Chino Valley, on a short spur facing west and southwest starting about 500 feet east of the NW cor., sec. 31, and ending in SW, sec. 30, T. 19 N., R. 2 W., Simmons quadrangle.
6. Stratigraphically the same as number 5. From the SW cor., sec. 30, T. 19 N., R. 3 W., and SE cor., sec. 25, T. 19 N., R. 3 W.
7. Same locality as number 5, but 121-130 feet above the base of member III.
8. Member IV. From 25 feet below the top of the formation in the canyon tributary to Sycamore Canyon on the west side about 2 miles (airline) north of the mouth; approximately sec. 32, T. 18 N., R. 3 E., Clarkdale quadrangle.



Text Figure II

Text-figure II. Stratigraphic distribution of corals in the Redwall limestone of Arizona. Numbers refer to the numbered members mentioned in the text. The columnar section is a stylized representation of the outcrops in the Jerome district. See page 10.

9. Member IV. About 50 feet from the top of the formation from bed 5A (of Noble, 1922, p. 56) on the west side of Bass Canyon ¼ mile north of Bass Trail; in Grand Canyon.
10. From 40-50 feet above the base of member III. From the pile of blocks on the southwest side of the hairpin bend on the road following the old narrow gauge railway at Bodkin, about 5 miles (airline) west-northwest from Jerome, Clarkdale quadrangle.
11. Float from member III. Same locality as number 6.
12. From clast of Redwall limestone in basal conglomerate of Supai (?) formation. Same locality as number 8.
13. From 10-15 feet above the base of member III. Same locality as 5.
14. From 25-30 feet above the base of member III. Same locality as 5.
15. From 30-35 feet above the base of member III. Same locality as 5.
16. From 15-20 feet above the base of member III. Same locality as 5.
17. From 2-10 feet above the base of member III. Same locality as 8.
18. From 268 feet above the base of the lower massive limestone of the Redwall limestone in Iceberg Canyon, Grand Canyon National Park; collected by E. D. McKee.
19. From 45-50 feet above the base of member III. Same locality as 5.
20. Member III. From northeast side of Hell Canyon about ¼ mile south of the railroad trestle along U. S. Highway 89; NE, NE, sec. 5, T. 18 N., R. 1 W.
21. From 20-25 feet above the base of member III. Same locality as 5.
22. From 5-10 feet above the base of member III. Same locality as 5.
23. From upper 30 feet of member IV. Same locality as 8.
24. From 0-5 feet above the base of member III. Same locality as 5.
25. From lower 4 or 5 feet of limestone 20 feet thick in the upper half of member I. From near the top of the south side of the butte in Lonesome Valley on the east side of Chino Valley, C, W½, NW, NE, NE, sec. 14, T. 16 N., R. 1 W., Paulden quadrangle.
26. From 50-55 feet above the base of member III. Same locality as 5.
27. From 60-65 feet above the base of member III. Same locality as 5.
28. From 10-27 feet above the base of member III. Same locality as 8.

29. From the upper 76 feet of member III. From the west-facing scarp of a northwest extension of Mingus Mountain; C, SE, sec. 25, T. 16 N., R. 1 E., Mingus Mountain quadrangle.
30. From member III. From the east-facing escarpment about 1.2 miles west of Jerome, in the steep wash in the SW, NE, sec. 21, T. 16 N., R. 2 E., Clarkdale quadrangle.
31. From bed A-2 in the upper massive limestone of the Redwall limestone in Parashant Canyon, Grand Canyon National Park; collected by E. D. McKee.
32. From member III. From same locality as number 5.
33. From 17½ feet below the top of member II. From the east side of a small fault in the east wall of Hell Canyon at the sharp bend; C, E½, NE, NE, sec. 30, T. 19 N., R. 1 W., Ash Fork quadrangle.
34. Undifferentiated Redwall limestone (probably from member III). From fault block on the east side of Elden Mountain in NE, SE, sec. 25, T. 22 N., R. 7 E., Flagstaff quadrangle, Coconino County, Arizona; collected by Major L. F. Brady.
35. Undifferentiated Redwall limestone. From near Natural Bridge, near C, S line, sec. 5, T. 11 N., R 9 E., Pine quadrangle.
36. From near the top of member I. From the same locality as 5.
37. From cherty limestone in the upper part of member II. From bench and bluff topography on slopes and tops of hills in N½, NE, SE, sec. 9, T. 18 N., R. 2 W., Paulden quadrangle.
38. Undifferentiated Redwall limestone (probably from member III). From Kilpatrick Spring at the same locality as 34. Collected by Major L. F. Brady.
39. Float from member III. From same locality as 5.
40. Undifferentiated Redwall limestone. From Marble Mountain (= Marble Hills, = White Horse Hills) in secs. 1, 12, T. 23 N., R. 6 E., and sec. 7, T. 23 N., R. 7 E., Flagstaff quadrangle, Coconino County, Arizona, Collector unknown.
41. Undifferentiated Redwall limestone. From above the Conrad Ranch, at same locality as 34. Collected by Major L. F. Brady.
42. Undifferentiated Redwall limestone. From Slate Mountain, about 6 miles north of Kendrick Peak, in NW¼, sec. 2, T. 24 N., R. 5 E., or SW¼, sec. 35, T. 25 N., R. 5 E., Flagstaff quadrangle, Coconino County, Arizona. Collector unknown.
43. From 35-40 feet above the base of member III. From same locality as 5.
44. From the base of the Redwall limestone, Quartermaster Canyon, Grand Canyon National Park. Collected by E. D. McKee.
45. From 6-26 feet above the solution breccia at the base of member IV. From the same locality as 30.

46. From the lower 41½ feet of member III. From the walls of the narrow canyon in Verde River in C, SE, sec. 27, T. 18 N., R. 1 E., Paulden quadrangle.
47. Slope collection from member IV. From same locality as 5.
48. From 13 feet below the top of member I. From same locality as 5.
49. From 40-45 feet above the base of member III. From same locality as 5.
50. From the upper part of the lower massive cliff. From same locality as 31. Collected by E. D. McKee.
51. From 80-85 feet above the base of member III. From same locality as 5.
52. From upper 25 feet of member I. From same locality as 29.
53. From either member I or II. From Sycamore Creek, probably in sec. 7, T. 11 N., R. 10 E., Gila County, Arizona. Collected by Major L. F. Brady.
54. From uppermost part of member IV. From same locality as number 30.
55. From member III. From Hell Canyon between Drake and Verde River.
56. Possibly from member IV. From same locality as 30.
57. From 22 feet below the top of member II. From same locality as 33.
58. From 25 feet above the base of member III. From same locality as 5.
59. Undifferentiated Redwall limestone. From the north side of Chino Valley in the Black Mesa. Probably the same as or very near 5.
60. From 39 feet above the base of member IV. From same locality as 8.

ACKNOWLEDGEMENTS

We are pleased to acknowledge the assistance of the following persons who have advanced us in this study by furnishing specimens or information on localities: Major L. F. Brady, Dr. E. D. McKee, and Dr. A. Stoyanow. The primary types and the majority of the collections have been deposited at the Museum of Northern Arizona at Flagstaff. Information on *Physetocrinus* was furnished by Mr. A. L. Bowsher.

SYSTEMATICS

Collections used in the following section are referred to as follows: MNA — Museum of Northern Arizona, Flagstaff, Arizona; USC — University of Southern California, Los Angeles, California; GCNP — Grand Canyon National Park Museum, Arizona; UI — University of Illinois, Urbana, Illinois.

Phylum Coelenterata
Class Anthozoa
Order Tetracoralla
Family Hapsiphyllidae Grabau, 1928, emend. Easton, 1944
Genus *Triplophyllites* Easton, 1944
Subgenus *Triplophyllites* Easton, 1951
Triplophyllites ellipticus species group

Triplophyllites (Triplophyllites) persimilis
Easton and Gutschick, n. sp.
Plate II, figures 5, 9

?1904. *Menophyllum excavatum.* Girty in Ransome, U. S. Geol. Surv., Prof. Pap. 21, p. 50. Escabrosa limestone, Arizona.
?1905. *Menophyllum excavatum.* Girty in Lee, U. S. Geol. Surv., Water Supp. Pap. 136, p. 97. Redwall limestone, Arizona.
?1908. *Menophyllum excavatum.* Girty in Lee, U. S. Geol. Surv., Bull. 352, p. 16. Redwall limestone, Arizona.
?1910. *Menophyllum excavatum.* Darton, U. S. Geol. Surv., Bull. 435, p. 24, Redwall limestone, Arizona.
?1914. *Menophyllum excavatum.* Girty in Noble, U. S. Geol. Surv., Bull. 549, p. 66. Redwall limestone, Arizona.
?1917. *Menophyllum excavatum.* Girty in Ransome, U. S. Geol. Surv. Prof. Pap. 98, pp. 147, 152. Escabrosa limestone and Carboniferous limestone, Arizona.

Externals. — Curved, trochoid, somewhat elliptical in cross-section, epitheca nearly smooth with encircling striae. Corals about 5 cm long. Cardinal fossula on the concave side of the coral. In very late ephebic stage the septa withdraw from the axis, become slender, and eventually exist as septal ridges on the inner surface of the epitheca. The calyx, therefore, is very deep.

Transverse sections. — In early ephebic stage, (diameters about 3.5 by 4.5 mm), there are 20 major septa, of which 4 lie on either side of the cardinal septum, which reaches the axis and lies in a narrow fossula. The counter septum is somewhat thickened. The cardinal fossula is bounded by thickened fused septal terminations which form a phyllotheca. No tabulae were observed.

Comparison. — This species differs from *Triplophyllites excavatus* (Girty), 1899, in having more septa than in that species. Otherwise it resembles *T. excavatus* in most details.

Material. — Specimen studied: 23. Holotype G2.4078; paratype G2.4079; other specimens, G2.100, G2.128, G2.4077; GCNP — FR 72. UI — not numbered.

Occurrence. — Localities 1, 10, ?13, ?16, ?19, 22, ?26, 33, 37, 38, 46, ?47, ?50.

Remarks. — Although Girty said in the original description *Menophyllum? excavatum* that it lacked tabulae, tabulae are shown on the inner edge of the cardinal fossula on one of his figures (Girty 1899, pl. 67, fig. 1c).

Various specimens referred in the literature to *Zaphrentis* sp. *Menophyllum* sp., and *Menophyllum excavatum* from the Redwall Madison, and Escabrosa limestones may be referable to *T. persimilis.* References only to Arizona specimens are included in the synonymy above, mostly for the sake of completeness. Specimens were not studied to substantiate the identifications so the references are all questioned. No typical *T. excavatus* was seen among the Redwall specimens studied, but that does not preclude the possibility that the species occurs in Arizona.

Subgenus *Homalophyllites* Easton, 1944 emend. Easton, 1951

Homalophyllites calceolus species group

Triplophyllites (Homalophyllites) paucicinctus

Easton and Gutschick, n. sp.

Plate I, figures 3, 5; Plate II, figures 6-8

Externals. — Medium size ceratoid to trochoid corals with marked flattening on convex side except in very advanced stages when the calyx may be circular. Epitheca generally smooth but with a few irregularly located rounded constrictions. Average length about 2.5 to 3 cm.

Transverse sections. — In very early ephebic stage (diameters 1.7 by 1.5 mm) there are 13 septa, of which the short cardinal septum is in a wide fossula and the cardinal quadrants contain 2 or 3 septa. At a slightly later stage (diameters 3.5 by 3.0 mm), there are 18 septa, of which the cardinal septum reaches almost to the center and each cardinal quadrant contains four septa. Later (diameters 6.0 by 5.0 mm) there are 24 septa, the cardinal fossula has become very narrow, the cardinal septum is short, and the cardinal quadrants contain 5 or 6 septa. At diameters 9.5 by 7.5 mm there are 34 septa, of which 7 or 8 are in each cardinal quadrant. In full maturity just above the floor of the calyx (diameters 17.0 by 12.0 mm) there are 46 major septa, of which 10 or 11 are in each cardinal quadrant. These are dilated and touch along almost their entire length, whereas the septa of the counter quadrants are somewhat thinner than the others and are free at their axial edges. Minor septa tend to be contratingent, especially in the cardinal quadrants. The peripheral portions of all septa are tightly appressed so that there is a dense border (namely a septal stereotheca).

Other mature sections show essentially the same features. There is apparently a very deep impression in the floor of the calyx that may lie within the cardinal fossula or extend into the alar fossulae as well, in which case the calicular pit is three-pronged. Occasionally a coral loses the flattening of the convex side and becomes round, in which case the septa may all be of about equal strength and separated by loculi, instead of being so excessively dilated.

LONGITUDINAL SECTION. — The solid nature of the corals prevents detailed interpretation of structure from longitudinal sections, however, the tabulae appear to be sparse, about 5 or 6 occurring in 5 mm and these sloping gently proximally and peripherally.

COMPARISON. — This species differs from *T. (Homalophyllites) calceolus* in having more septa, which are much more densely packed together, in being somewhat larger, and in having fewer and less sharply defined constrictions of the corallite.

MATERIAL. — Specimens studied: 124. Holotype G2.4181; paratypes G2.4182; ideotypes G2.4131, G2.4132, G2.4179; other specimens G2.87, G2.100, G2.107, G2.123, G2.127, G2.155, G2.217, G2.4096-G2.4130, G2.4186-G2.4188, G2.4191. USC 3053. UI not numbered.

OCCURRENCE. — Localities 1, 3, 7, 10, 12-17, 19-22, 24-31, 34, 35, 38, 40, 41, 43, 45, 49.

Homalophyllites reversus species group

Triplophyllites (Homalophyllites) subcrassus

Easton and Gutschick, n. sp.

Plate I, figure 4; Plate II, figures 1-4

EXTERNALS. — Corals slightly curved, ceratoid, circular in cross-section. Calyces deep, evenly concave, with 40 to 44 major septa in mature calyces reaching almost to axis at floor but being progressively shorter near expitheca. Epitheca smooth, without noticeable constrictions. Length of mature corallites about 3 cm, diameter of mature calyces about 11 mm.

TRANSVERSE SECTIONS. — The holotype in middle ephebic stage (diameters 8.5 by 9.5 mm) has 36 major septa with very short contratingent minor septa commonly fused to peripheral edges of major septa. The cardinal septum is joined on either side near the tip by a major septum. There are 8 major septa in the right cardinal quadrant. Tabulae common.

At a slightly younger stage (diameters 8.0 by 7.5 mm) there are 32 major septa, of which the cardinal septum is fairly short, the counter septum is not fused with adjacent septa, and each cardinal quadrant contains 7 major septa. Minor septa are short, free at their axial edges, and tend to learn towards the counter position. The cardinal fossula is slightly expanded axially and not especially narrow.

COMPARISON. — This species differs from *T. (Homalophyllites) paucicinctus* in being somewhat smaller, circular in cross-section, with more slender major septa which do not form a wide peripheral sclerotheca, and in lacking the constrictions of the epitheca.

MATERIAL. — Specimens studied: 50. Holotype G2.4178; paratypes G2.4180, G2.4089-G2.4091; topotypes G2.4081; other specimens G2.2234, G2.4080, G2.4082-G2.4088, G2.4189, G2.4190. USC 3054, topotypes.

OCCURRENCE. — Localities 3, 11, 12, 23, 42, 45.

Family Caniniidae

Genus *Caninophyllum* Lewis, 1929

REMARKS. – The genus has heretofore been reported from the Lower Carboniferous of Belgium, France, the British Isles, Australia, and possibly from Oregon and China. Essential data have been quoted previously in American Literature (Easton, 1944, p. 130).

Caninophyllum incrassatum

Easton and Gutschick, n. sp.

Plate III, figures 1-4

1905. ? *Cyathophyllum* sp. Girty in Lee, U. S. Geol. Surv., Water Supp. Pap. 136, p. 97. Redwall limestone, Arizona.

1917. ? *Cyathophyllum* sp. Girty in Ransome, U. S. Geol. Surv., Prof. Pap. 98, p. 152, Carboniferous limestone, Arizona.

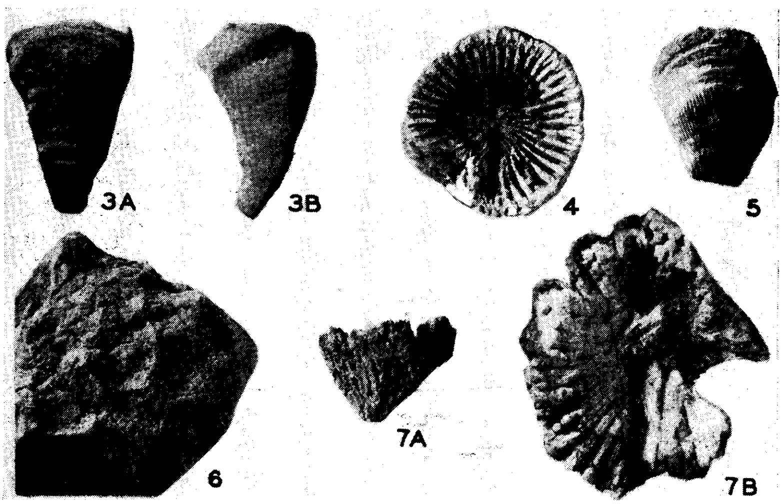


Plate I

EXPLANATION OF PLATE I

Figs. 3, 5. *Triplophyllites (Homalophyllites) paucicinctus* Easton and Gutschick, n. sp.; holotype; MNA G2.4181; 1X. *3a,* Cardinal side. *3b,* Left alar side. 5, cardinal side of a specimen weathered to show traces of septa; 1X; paratype .... p. 15

Fig. 4. *Triplophyllites (Homalophyllites) subcrassus* Easton and Gutschick, n. sp.; holotype; MNA G2.4178; 2X........ p. 16

Fig. 6. *Pleurodictyum expansum* (White); hypotype; MNA G2.4177; surface of colony; 1X........ p. 24

Fig. 7. Genus and species not determined, MNA G2.4183. *7a,* Left alar side, 1X. *7b,* Calyx, 2X........ p. 21

EXTERNALS. — Corallites very large, conico-cylindrical; specimens attain lengths of about 15 cm and diameters of 4 cm. Calyx of a specimen (GCNP - FR 116A) 4 cm in diameter is 3.5 cm deep and has a flat calical floor 1.5 cm in diameter; epitheca with faint interseptal ridges and bourrelets.

TRANSVERSE SECTIONS. — In early ephebic stage, 36 long major septa and an equal number of rudimentary minor septa are present. The major septa are much dilated within the tabularium and most of them nearly reach the axis; they are bunched together in four groups. A few lonsdaleoid dissepiments are present.

In middle ephebic stage, there are 38 long major septa which are even more dilated within the tabularium now than in earlier stages. The quadripartite grouping of major septa still persists. Minor septa are rare and are obscure because they are incorporated within the dissepimentarium. Dissepiments still tend to be mostly interseptal, although an occasional lonsdaleoid dissepiment is present.

The development of the coral is very well shown in serial sections of the holotype and a paratype in the same piece of rock. At the earliest stage observed in the paratype (diameter about 2.5 mm) there appears to be a median plate and other septa, but the precise number cannot be determined. At a diameter of about 3.5 mm the cardinal septum is long and very dilated, and occurs on the flattened side of the section; about 11 other septa are present, of which about 3 on either side of the cardinal septum are short and obscure; tabulae are present. At a diameter of about 4 mm[1] there are about 14 septa, arranged very much as in the preceding section, except that the counter septum is very long. At a diameter of about 8 mm there are 24 very dilated septa, most of which nearly reach the axis. Development in the holotype from here on shows 26 septa at a maximum diameter of 10.5 mm, very much as described for the preceding stage, but the outline of the corallite is crescentic or semicircular with the cardinal side on the flattened side. The first indication of dissepiments was noted just beyond this stage, but by the time there are 34 still much dilated septa (diameters 10.0 by 11.5 mm) there is not yet a definite dissepimentarium. A few lonsdaleoid dissepiments occur when there are still 36 septa (diameters 13.5 by 16 mm) and there is a true dissepimentarium by the time 38 major septa are present (diameters 18.5 by 20.0 mm); a few minor septa are also present at the inner edge of the tabularium. As growth proceeded in subsequent stages, the minor septa continue to be restricted to the same region, but the major septa extend outward peripherally as thin plates half the diameter of the dissepimentarium so that half

[1]This stage is very similar to that of **V. sedaliense** figured by the writer (1944 pl. 5, fig. 7).

the dissepiments are interseptal and half are lonsdaleoid. In some sections most septa are interseptal.

LONGITUDINAL SECTION. — Dissepiments very steeply tilted, elongate, and thin-walled. Tabulae slope axially and proximally.

COMPARISON. — This species differs from *C.* ? *readi* (Merriam) in having relatively longer major septa which are more dilated, fewer minor septa, and in being somewhat smaller.

MATERIAL. — Specimens studied: 51. Holotype G2.4155; paratypes G2.4143, G2.4151, G2.4153, G2.4154; ideotypes G2.4152, G2.4176; other specimens, G2.2044, G2.4133, G2.4150-G2.4156, G2.4185; GCNP-FR 70A, 70B, 91, 104, 112, 116, 119, 122, 123, 128.

OCCURRENCE. — Localities 1, 2, 5-8, 10, 12, 14, 18, 19, 21, 31, 32, 36, 44, ?45, 50, ?51.

REMARKS. — It was observed that there may be another phase of this species in which the corallites tend to retain a long slender habit, do not have lonsdaleoid dissepiments so early, if at all, and tend to have more slender septa (Plate III, fiure 4). Subsequent work may provide reason for separating this phase taxonomically or perhaps explaining it on an ecologic basis. For the present, the writer prefers to designate it as simply "slender phase" of *C. incrassatum*. It occurs at localities 10, 14, 19, 45, 50, ?51. It is represented in the collection by MNA G2.4135, G2.4147, G2.4150, G2.4141, G2.4134, G2.4136. The species can be referred to Lewis' "Monense" type of the genotype, *C. archiaci*, which is characteristic of the S_2-D_1 beds of the British Isles.

Family *Lithostrotiontidae* (Grabau 1927) Chi, 1931
Genus *Lithostrotion* Fleming, 1828
Genomorph *Lithostrotionella* Yabe and Hayasaka, 1915

REMARKS. — The writers are following the systematic arrangement used by McLaren and Sutherland (1949, p. 629) in their excellent restudy of *Lithostrotion*. Following their usage, the name of the genomorph is placed in brackets after the generic name, as follows.

Lithostrotion (Lithostrotionella) circinatus
Easton and Gutschick, n. sp.

Plate III, figures 5, 6

TRANSVERSE SECTIONS. — In early ephebic stages when the corallites measure 3 or 4 mm in diameter, there are about 12 or 14 septa, of which approximately half of them (probably major septa) reach the axis and the remainder do not (probably minor septa). Even at this early stage the tendency for lonsdaleoid retreat of septa is strong, although some septa do reach the epitheca. The columella is weakly developed and may be represented by a very slightly thickened axial plate or in some cases be absent entirely. Dilation of septal portions within the inner wall is only faintly indicated.

In mature corallites about 10 mm in diameter, about 22 major septa are present, most of which reach the columella and are quite dilated within the inner wall. Lonsdaleoid dissepiments are abundant although occasionally a septum may reach the epitheca. Minor septa barely extend beyond the inner wall. The columella is rounded except for small thickened outgrowths where major septa meet it.

In late maturity, the major septa tend to retreat from the columella, which then appears quite smooth and oval except where a stronger septum at one end (presumably the counter septum) is fused with it. Minor septa may appear as septal crests.

In all mature stages the intersections of tabulae are convex axially, which means that although the tabulae slope peripherally and proximally, they sag proximally between septa. In addition, the coralla are always composed of polygonal cerioid corallites.

LONGITUDINAL SECTION. — The dissepiments are narrow and elongate and lie at an angle of about 20° with the axis. The generally incomplete tabulae slope axially and proximally at an angle of about 70°, approach being horizontal at their ends, and number about 12 in 5 mm.

COMPARISON. — This species differs from *Lithostrotionella hemisphaerica* Hayasaka in having generally narrow corallites, less steeply sloping dissepiments, more steeply sloping tabulae which are more closely spaced, fewer septa, and rounded columella.

MATERIAL. — Specimens studied: 3. Holotype G2.4157; paratype G2.4158; topotype G2.4159; other specimen, G2.4162. USC 3050, peel sections of holotype.

OCCURRENCE. — Localities 1, 2, 65.

Lithostrotion (Diphyphyllum) ? inconstans

Easton and Gutschick, n. sp.

Plate II, figures 10-12

1922. ?*Diphyphyllum* sp. Girty in Noble, U. S. Geol. Survey, Prof. Pap. 131-B, p. 56. (Redwall limestone, Arizona.)

1922. ?*Diphyphyllum (Lithostrotion?)* sp. Girty in Noble, U. S. Geol. Survey, Prof. Pap. 131-B, p. 56 (Redwall limestone, Arizona).

TRANSVERSE SECTIONS. — In mature corallites about 9 mm in diameter, there are 26 or 28 septa which extend slightly more than half the radius, are thin, and although they generally reach the epitheca, they may be interrupted by lonsdaleoid dissepiments. A narrow inner wall is present.

The coralla apparently are loosely fasciculate to nearly massive, the holotype showing three sub-polygonal corallites at one place and scattered corallites elsewhere, whereas the ideotype seems to be loosely fasciculate.

The axial plate was tentatively identified in one transverse section.

LONGITUDINAL SECTIONS. — Tabulae nearly all complete, strongly recurved proximally near their peripheries, essentially flat over the axial region and numbering 8 or 10 in 5 mm. Dissepiments in one or, rarely, two ranges, steeply sloping, varying from being rounded to being elongate and narrow. Inner wall irregularly sinuous.

One oblique longitudinal section shows a short rather thick columella with the tabulae sharply arched distally and axially immediately adjacent to it.

COMPARISON. — This species differs from *D. mutabile* Kelly in having larger corallites, longer and more numerous septa, a much more impersistent columella and rarely arched tabulae, and probably more tightly massed corallites.

MATERIAL. — Specimens studied: 8. Holotype, G2.4160; ideotype, G2.4161. USC 3051, thin section of holotype; GCNP-FR 82, 84, 94, 95, 100, 143.

OCCURRENCE. — Localities 1, 3, ?4, 9, 18, 31.

REMARKS. — The species combines the characters of some described "genera" or genomorphs, namely, *Diphyphyllum, Dorlodotia, Lithostrotion,* and *Thysanophyllum.* It is here placed questionably in the genomorph *Diphyphyllum* because it most commonly exhibits the characters of that group. One section, however, (see plate II, figure 11), shows a discontinuous columella in the form of a median plate. Scattered traces of this feature were noted on other sections not illustrated.

No coral similar to this has been reported from the standard Mississippian section of the United States.

Position Uncertain

Genus and species unidentified

Plate I, figures 7a, 7b

REMARKS. — Two silicified specimens of a short patellate coral were collected. One has 28 major septa and an equal number of rudimentary minor septa; the apical angle is 90°. The other, with an apical angle of 80° had perhaps 36 or 38 major septa when complete. The calyx is deep and the walls are parallel with the epitheca. The corals are about 1.5 cm tall and the calyces are about 1.5 cm in diameter.

MATERIAL. — Specimens studied: 2. G2.183, G2.4183.

OCCURRENCE. — Localities 35, 52.

Order Tabulata

Family Syringoporidae Milne-Edwards and Haime

Genus *Syringopora* Goldfuss, 1826

REMARKS. — The specimens studied herein are typical of *Syringopora,* being without bundles of lateral processes, and without extraordinarily thick walls.

Knowledge of the syringoporoids is not highly refined. *S. surcularia* and *S. aculeata* identified below are in the nature of form species based on the diameter of the corallites, the density of colonial packing, and the nature of the septal spines.

References in the literature to *Syringopora* sp. and *S. harveyi* are not included in the synonymies below because the specimens were not studied. The writer saw no specimens of *S. harveyi* among the Redwall specimens. It is quite probable that the specimens of *S. harveyi* reported from the Redwall should be referred to *S. aculeata* on the basis of similar diameters of corallites.

Syringopora aculeata Girty, 1899

Plate II, figures 13-16

1899. *Syringopora aculeata* Girty, U. S. Geol. Survey, Mon. 32, pt. 2, pp. 484, 509, pl. 67, figs. 5a, b. (Madison limestone, Wyoming.)

1904. *Syringopora aculeata.* Girty in Ransome, U. S. Geol. Survey, Prof. Pap. 21, p. 50. (Escabrosa limestone, Arizona.)

1905. *Syringopora aculeata.* Girty in Lee, U. S. Geol. Survey Water Supp. Pap. 136, p. 97. (Redwall limestone, Arizona.)

1917. *Syringopora aculeata.* Girty in Ransome, U. S. Geol. Survey, Prof. Pap. 98, pp. 143, 147, 152. (Tornado limestone, Arizona.)

DIAGNOSIS. – *Syringopora* with corallites about 1.5 mm in diameter usually separated from adjacent corallites by about 3 mm. Epitheca with encircling striae. Lateral processes scarce, not arranged in planes or groups of three or four at each point of connection.

In transverse section the septal spines are short and sharp numbering about 24 to 30, and apparently confined to the epitheca. Tabular intersections arranged in about ten irregularly concentric ellipses whose centers are not axially located.

In longitudinal section the tabulae overlap proximally in one to three ranges so that they are about twice as long as wide. Tabulae on each half occupy about one-third of the diameter. Central tube, in which transverse tabulae were not observed, occupies about one-third of the diameter. Rows of septal spines are visible occasionally, arranged in vertical series.

MATERIAL. – Specimens studied: 31. Hypotype: G2.1355, G2.4171. Other specimens: G2.101, G2.173, G2.181, G2.1249, G2.1354, G2.4163-G2.4170, G2.4172-G2.4175. USC 3052, thin sections of hypotype; GCNP-FR 71.

LOCALITIES. – 13, 22, 35, 37, 39, 40, 45, 50, 53, 55, 57, 59-62.

Syringopora surcularia Girty, 1899

1899. *Syringopora surcularia* Girty, U. S. Geol. Survey, Mon. 32, pt. 2, pp. 484, 510, pl. 67, figs. 4a, b. (Madison limestone, Wyoming.)

1905. *Syringopora surcularia.* Girty in Lee, U. S. Geol. Survey, Water Supp. Pap. 136, p. 97. (Redwall limestone, Arizona.)
1912. *Syringopora surcularia.* Girty in Willis, U. S. Geol. Survey, Prof. Pap. 71, p. 381. (Madison limestone, Montana.)
1913. *Syringopora surcularia.* Girty in Umpleby, U. S. Geol. Survey, Bull. 528, p. 35. (Mississippian, Idaho.)
1917. *Syringopora surcularia.* Girty in Ransome, U. S. Geol. Survey, Prof. Pap. 98, p. 152. (Carboniferous limestone, Arizona.)
1932. *Syringopora surcularia.* Girty in Westgate and Knopf, U. S. Geol. Survey, Prof. Pap. 172, p. 20. (Bristol Pass limestone, Nevada.)
1932. *Syringopora surcularia.* Girty in Gilluly, U. S. Geol. Survey, Prof. Pap. 173, pp. 23, 24. (Madison limestone, Utah.)

DIAGNOSIS. — *Syringopora* with corallites about 2.5 mm in diameter, usually separated from adjacent corallites by about 4 mm. Epitheca almost smooth, with irregular swellings and minor contortions or flexures. Lateral processes scarce, not arranged in groups.

In transverse section the epitheca is a little thickened. Septal spines are scarce, very short, and are confined to the epitheca. Tabular intersections are arranged in about 8 concentric ellipses closely packed together whose center of symmetry is excentrically located.

In longitudinal section the tabulae overlap proximally in one to three ranges so that they are about three times as long as wide. Each peripheral tabular zone occupies a little more than one-third of the diameter. Central tube, in which transverse tabulae were not observed, occupying a little less than one-third of the diameter.

MATERIAL. — Specimens studied: 6. Nos. G2.122, G2.4092-G2.4095.

LOCALITIES. — 29, 34, 37, 63, 64.

Family Favositidae Milne-Edwards and Haime

Genus *Pleurodictyum* Goldfuss, 1829

REMARKS. — Easton (1944, p. 55) and Moore and Jeffords (1945, p. 167) have briefly reviewed the status of *Pleurodictyum* but reached divergent conclusions. The latter students consider *Michelinia* to be generically distinct, whereas the former does not. This lack of agreement is typical of the two prevailing attitudes among paleontologists regarding the status of the genera.

A specimen of the genotype of *Pleurodictyum, P. problematicum* Goldfuss, 1829, at hand shows some features of interest in this minor conflict of opinions. The specimen is an internal filling in which details are preserved with extraordinary fidelity. The walls are rather uniformly about 0.6 mm thick; comparatively, then, they are only half as thick as are those in some species which are referred to the generically thin-walled *Michelinia.* Mural pores, which in this specimen are delicate solid rods because of the manner of preservation, are of three sorts: transversely disposed, obliquely disposed, or arching across the space between corallites. Most, to be sure, are more or less transverse, but several quite clearly pass lengthwise for a short distance within the mass of the corallite wall before they complete the passage. This phenomenon is best observed at the proximal ends of corallites. The feature is therefore not characteristic of *Michelinia* but also of *Pleurodictyum.* Tabulae are not observable because of the manner of preservation.

It appears, then, that if *Michelinia* is to be separated from *Pleurodictyum,* it will have to be on the basis of the former's having thicker coralla and more tabula per unit distance than have the latter. It does not seem feasible to the writers to make the generic separation on these grounds.

Pleurodictyum expansum (White), 1880

Plate I, figure 6

1944. *Pleurodictyum expansum.* Easton, Illinois Geol. Survey, Rept. Inv. 97, p. 55, pl. 13, fig. 9; pl. 17, fig. 2. (Contains prior synonymy) (Upper Chouteau limestone, Missouri).

This species is represented by a colony measuring 9 by 5 cm and is 3.5 cm thick. Corallites measure 8 or 9 mm in diameter and are mostly hexagonal. Tabulae occur about 9 in one cm. The specimen is extensively replaced and therefore is not suitable for study of internal details in thin section.

MATERIAL. — Specimens studied: 1. Hypotype: G2. 4177.

OCCURRENCE. — Locality 30.

EXPLANATION OF PLATE II

Figs. 1-4. *Triplophyllites (Homalophyllites) subcrassus* E. and G., n. sp. 2.5X *1,* Early ephebic stage; ideotype; No. G2.4091. *3,* Early ephebic stage; holotype; No. G2.4178. *2,* Late ephebic stage; ideotype; No. G2.4089. *4,* Early ephebic stage; ideotype; No. G2.4090..........p. 16

Figs. 5, 9. *Triplophyllites (Triplophyllites) persimilis* E. and G., n. sp. holotype; No. G2.4078; 2.5X. *5,* Late neanic stage. *9,* Middle ephebic stage ....p. 14

Figs. 6-8. *Triplophyllites (Homalophyllites) paucicinctus* Easton, n. sp. 2.5X. *6,* Late ephebic stage, just above floor of calyx; paratype; No. G2.4182. *7,* Late ephebic stage; ideotype; No. G2.4131. *8,* Middle ephebic stage; ideotype; No. G2.4132..........p. 75

Figs. 10-12. *Lithostrotion [Diphyphyllum]? inconstans* E. and G. n. sp.; holotype; No. G2.4160; 2.5X. *10,* Ephebic stage showing rejuvenescence. *11,* Longitudinal section showing axial plate; this surface subsequently ground away in the course of study. *12,* Longitudinal section without axial plate ....p. 26

Figs. 13-16. *Syringopora aculeata* Girty, 1899; hypotypes. *13,* Longitudinal section; No. G2.4171; 3.5X. *14,* Tangential section, somewhat diagrammatic, showing linear rows of septal spines; No. G2.4171; 3.5X. *15,* Longitudinal section; No. G2.1355; 2.5X. *16,* Transverse section of colony showing variation in 8 corallites; No. G2.1355; 2.5X..........p. 22

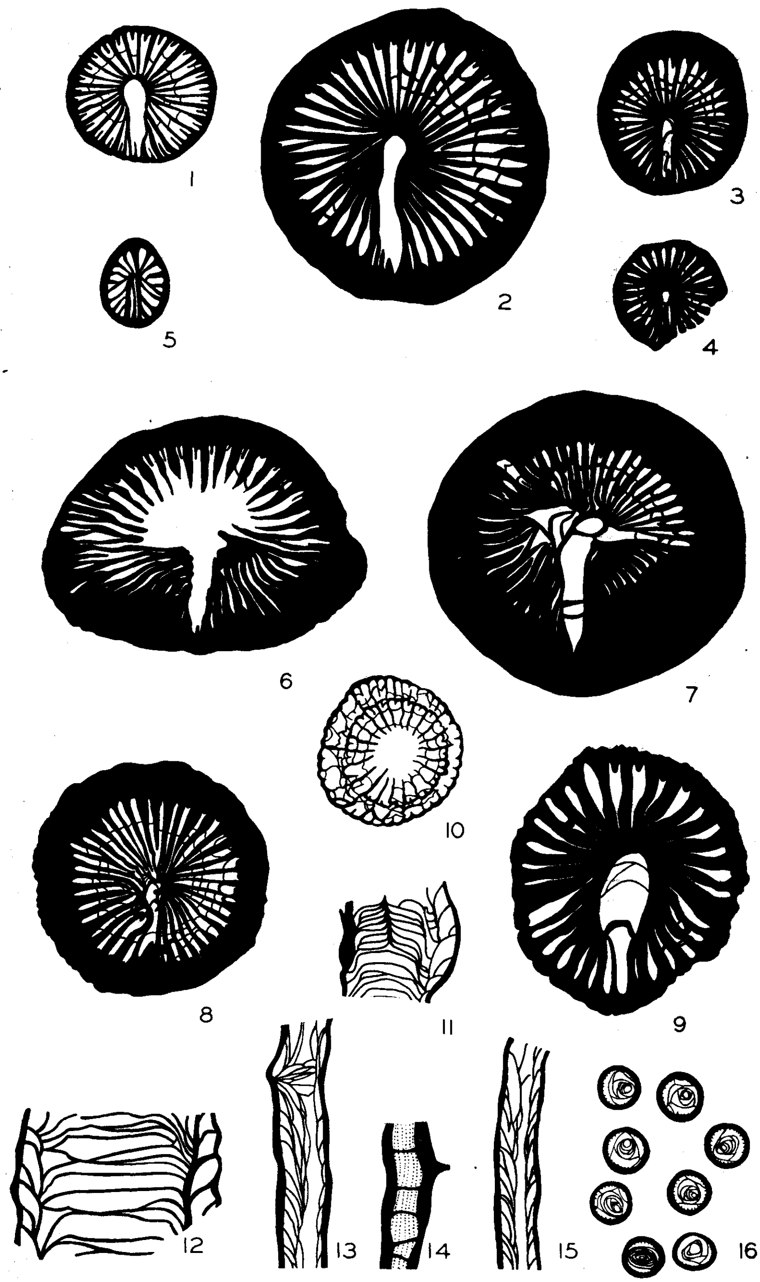
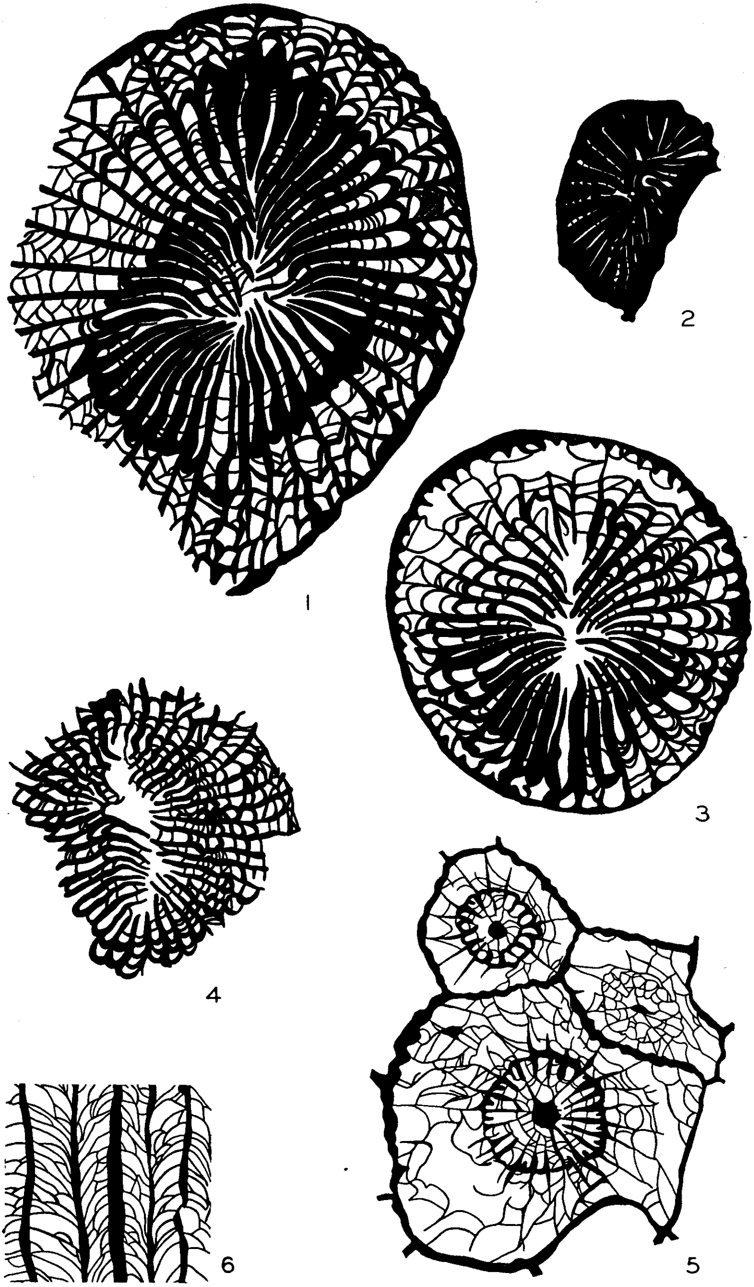


PLATE II



EXPLANATION OF PLATE III

Figs. 1-4. *Caninophyllum incrassatum* E. and G. n. sp. 2.5X. *1,* Middle ephebic stage; *paratype;* No. G2.4151. 2, Late neanic stage; holotype; No. G2.4155. *3,* Early ephebic stage; paratype; No. G2.4154. *4,* Slender phase of the species, early ephebic stage; ideotype; No. G2.4152........p. 17

Figs. 5, 6. *Lithostrotion [Lithostrotionella] circinatus* E. and G. n. sp. holotype; No. G2.4157; 3.5X. *5,* Transverse section. *6,* Longitudinal section; center broad vertical line is axial rod; outermost vertical lines on each side are traces of theca..........p. 19

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