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CANADA

DEPARTMENT OF MINES AND TECHNICAL SURVEYS

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GEOLOGICAL SURVEY OF CANADA  
BULLETIN 24

THE CORAL MICROCYCLUS AND  
SOME OF ITS DEVONIAN SPECIES

BY  
Clinton R. Stauffer



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EDMOND CLOUTIER, C.M.G., O.A., D.S.P.  
QUEEN'S PRINTER AND CONTROLLER OF STATIONERY  
OTTAWA, 1952

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## PREFACE

Formations of the Devonian System have recently acquired special significance in Canada in view of the important role they are playing in the rapid development of the Canadian petroleum industry. Consequently, great interest is attached to the study of Devonian fossils, as these are used to elucidate the geological history of the oil-bearing formations in which they occur, and enable these formations to be traced over wide areas or correlated from one region to another.

The present report deals in some detail with the coral genus *Microcyclus*, which was first described from the Middle Devonian of Illinois in 1868. This small, button-like fossil was later found to be an important element in the faunas of the Hamilton formation in southwestern Ontario. The author, who has had many years of experience with Devonian faunas of North America, redefines a number of the older species of *Microcyclus*, and describes and illustrates several new ones from both Illinois and Ontario. This information will afford a valuable contribution to our knowledge of Canadian Devonian faunas.

HANS FREBOLD,  
*Chief, Division of Stratigraphic Palæontology,  
Geological Survey of Canada*

OTTAWA, May 10, 1952



# THE CORAL MICROCYCLUS AND SOME OF ITS DEVONIAN SPECIES

## INTRODUCTION

### GENERAL STATEMENT

The coral known under the generic name of *Microcyclus* was first obtained by Meek and Worthen at Grand Tower, Jackson county, Illinois, where it is a fairly common fossil in the "Hamilton beds" (Lingle limestone). Thousands of specimens, belonging to several different species of the genus, more recently have been obtained from Hamilton beds (Arkona shale) in the Thedford-Arkona region of Ontario, where the genus has been found to be among the typical and commonly abundant Canadian Middle Devonian corals. Although not a reef-builder, it is gregarious in habit and its species do have a rather limited vertical range. They thus become important horizon markers in the area over which they are known to occur.

### ACKNOWLEDGMENTS

For many specimens of *Microcyclus* the writer is indebted to a number of geologists, palæontologists, and collectors who have been willing and able to contribute materials for additional work on this genus. Among those furnishing collections from the *Microcyclus* zone at Grand Tower, Illinois, are Dr. Kenneth G. Brill Jr. of Saint Louis University, Dr. G. Arthur Cooper of the United States National Museum, Dr. Bernhard Kummel of the University of Illinois, and Dr. David H. Swann of the State Geological Survey of Illinois. The writer has often collected *Microcyclus* from the Arkona shale in the Thedford-Arkona region of Ontario and has been interested in the genus for years, but he is especially indebted to Mr. and Mrs. Charles Southworth of Thedford for a very large number of specimens recently collected in that part of the province. These latter form a major part of the material available.

### GENERAL DISCUSSION

*Microcyclus* is a medium to small discoid or flattened button-shaped solitary coral, which is usually attached and limited to definite horizons, commonly in the Middle Devonian or Hamilton group of North America, with one or two reported from the Mississippian. Rarely conspicuous or especially abundant, *Microcyclus* occurs over a wide area, within limited parts of which it may be fairly abundant though even there not to the exclusion of other fossil forms ordinarily occurring in the same beds. At Thedford, Ontario, the *Microcyclus* beds are commonly crowded with ostracodes, and the shells of these small crustaceans may be so matted in the calyx of *Microcyclus* that they interfere seriously with a study of the coral. In North America, the genus, so far as known, has its best development in the Arkona shale of the Thedford-Arkona region of southwestern Ontario, where several species occur and probably all with unusually variable



characteristics. Much of the area over which *Microcyclus* naturally would be expected to occur is heavily drift covered, so that relatively little is known of its real abundance and distribution. However, it is reported from Ontario, Michigan, New York, Virginia, Illinois, Missouri, Fort Norman in the Mackenzie District of Canada, Spain, and eastward into Germany.

The genus *Microcyclus* was described by F. B. Meek and A. H. Worthen (9)<sup>1</sup> in 1868 from specimens found in limestones at "Devil's Backbone" near Grand Tower, Jackson county, Illinois, where several square miles of Devonian rocks have been brought to the surface by diastrophic movements and subsequent erosion. The upper beds of this outcrop are referred to by Meek and Worthen as belonging to the "Hamilton Group", and are described as dark grey, siliceous, fetid limestone, with intercalations of calcareous shales. The *Microcyclus* zone is at the bottom of this "Hamilton Group" and forms the 10 feet of calcareous beds (Lingle limestone) that overlie the Grand Tower limestone unconformably near the northern end of the "Devil's Backbone" ridge. Dr. Cooper (5) regards these beds carrying *Microcyclus* as probably Marcellus in age and reports that the zone also occurs across Mississippi River near Seventysix, Missouri. However, Dr. T. E. Savage (12) says the Misenheimer shale, containing "numerous shells of *Leiorhynchus limitare*" and thus suggesting the Marcellus, occurs between the Lingle limestone and the Grand Tower limestone; but, apparently, it has pinched out at some point south of the Grand Tower region leaving the Lingle resting on the Grand Tower limestone.

The genotype is *Microcyclus discus* M. and W., which for many years was the only recognized American species, as Meek's *Microcyclus*(?) *multiradiatus* was originally described as a *Combophyllum*. Meek and Worthen's drawing of the under or proximal side of a large specimen, 20 mm. in diameter, gives a fair idea of that side, although it fails to show the radiating septal bases so well shown through the epitheca on some of the large, well-preserved specimens from the type locality. Unfortunately, Meek and Worthen used one of the smaller and somewhat different specimens to show the distal surface or interior of the calyx. Hence, their illustration (9, Figure 7b) of a specimen 15 mm. in diameter can scarcely be considered typical of those, from the same regional outcrop, illustrated by Dr. R. S. Bassler (1). Part of this difference, of course, is that of a mediocre drawing compared with Bassler's excellent photographs. But the drawing also is not like the larger specimens 20 mm. to 22 mm. in diameter, from Grand Tower, although the type showing the calyx may be fairly well matched in characteristics by specimens of similar size, 15 mm. in diameter or smaller, recently from the type locality. Meek and Worthen's description of the distal side or inside of the calyx is evidently drawn chiefly from the smaller specimen. That the corresponding part of the larger specimen was not used for greater detail is certainly lamentable, but it may have been partly obscured by adherent rock material, for this species occurs in a dense limestone difficult to remove from the calyx. It was doubtless the use of these differing specimens and the resultant confusion that led Nicholson, Whiteaves, Miller, Lambe, Grabau, and others to identify the Ontario specimens as *Microcyclus discus* M. and W. or variants of it.

<sup>1</sup> Numbers in parentheses are those of references in Bibliography at the end of this report.

Nicholson's illustration (11, Figure 9a) only remotely resembles that of the type by Meek and Worthen, and his passing remarks about the species add little to its identification. The Nicholson illustrations are undoubtedly drawings of his only well-preserved specimen from Bartlett's Mills (Hungry Hollow), near Arkona, Ontario, and can be approximately duplicated by other specimens that have been collected at the same locality. Whiteaves (18) and Stauffer (15) merely mention the species as part of their respective lists of the Ontario Devonian fauna; Miller (10) copied Nicholson's figure; Eastman's translation of Zittel (6) gives a figure reported to be after Nicholson although it is not a duplicate of the one given by him in his 1874 report; and Grabau and Shimer (7) figure an entirely different specimen as *Microcyclus discus* M. and W. None of these latter, therefore, are figures of, or references to, the true *Microcyclus discus* if we accept the Meek and Worthen form as type. As many of the identifications, especially in Ontario, have been made after Nicholson rather than after Meek and Worthen, these all are obviously incorrect.

Lawrence M. Lambe (8) published no illustrations of his Ontario specimens, but he gave an excellent description of a *Microcyclus* found in the Hamilton beds at Widder and along Ausable River. Unfortunately, he referred his specimens without question to the Meek and Worthen species, *Microcyclus discus* of Illinois, as Nicholson and others had done before. Lambe's remark that the species is "not uncommon in the Hamilton formation of Ontario" suggests that he had plenty of Canadian material available although perhaps none from the genotype locality in Illinois. His statement that it is "generally not more than 9 mm. in maximum thickness", however, leads one to suspect either that he had a few fragments of other corals in the lot he was studying or, more probably, that the number for thickness is a typographical error. The writer has collected many specimens in the Thedford-Arkona region, and has acquired many more from Mr. and Mrs. Charles Southworth of Thedford. In the clay pit at the Tile Yard, Thedford, a thin lens of shaly limestone about 5 feet in diameter recently yielded them nearly a thousand specimens of *Microcyclus*. Most of that material, together with more than a thousand other specimens, is in the writer's possession. Among all these and others that have been examined there are none that approach such unusual thickness. In fact, it is believed Lambe's maximum should be 3 mm.—a figure that easily could have been accidentally replaced by a 9 mm., in type setting, and this might have passed the proof-reader without detection. Such interpretation would conform more nearly with a maximum thickness of 4 mm. in a very large *Microcyclus discus* M. and W. from the type locality in Illinois and not exceeded by the smaller species from the Thedford-Arkona region. However, a very gibbous new species from Grand Tower, described herein, does have a thickness of 6 mm.

The reference, by so many writers, to the Nicholson figures has tended to shift attention away from the Meek and Worthen figures of the Illinois species to those of the one from the Arkona shale of Ontario, and Nicholson's figure of the calyx is the one that has been generally copied by other authors. Although they both occur in the lower part of the Hamilton, the Grand Tower and the Thedford-Arkona *Microcyclus* zones probably repre-

sent somewhat different horizons. Among the fossil species commonly associated with *Microcyclus* in Illinois (12) are *Athyris spiriferoides* (Eaton), *Chonetes coronatus* (Conrad), *Muscrospirifer mucronatus* (Conrad), *Pustulina pustulosa* (Hall), *Spinocyrtia granulosa* (Conrad), *Tropidoleptus carinatus* (Conrad), together with crinoid fragments, ostracodes, and trilobites. In the *Microcyclus* fauna of the Arkona shale of Ontario are such accompanying species as *Xenocyathellus thedfordensis* (Stewart), *Ancyrocrinus bulbosus* (Hall), *Ascodictyon stellata* Nicholson and Etheridge, *Chonetes scitulus* Hall, *Muscrospirifer arkonensis* (Grabau and Shimer), *Stropheodonta demissa* (Conrad), *Nucula lirata* (Conrad), *Paleoneilo emarginata* (Conrad), *Tentaculites bellulus* Hall, etc., together with crinoid fragments, trilobites, and numerous ostracodes. Moreover, the species belonging to *Microcyclus* may all be different from those found in Illinois.

Rather recently, R. S. Bassler (1) has given a more detailed definition of the genus *Microcyclus* as well as some excellent photographic illustrations of specimens from the type locality, together with a redescription of the genotype *Microcyclus discus* M. and W. He described only the larger form, which is presumably the one Meek and Worthen used to illustrate the proximal or under side, although not the same specimen. This may be desirable, but it seems to limit the Meek and Worthen name to the larger and perhaps more typical form occurring in the Grand Tower region or genotype locality, and discards some interesting small specimens. The common Ontario form, for many years confused with *Microcyclus discus* M. and W. of Illinois, Bassler has described as *Microcyclus thedfordensis*, which is a new and distinct species. It is not like any of the known forms from Illinois, although a long series of this abundant Canadian form includes specimens that lend some justification for the confusion between it and the genotype that prevailed for many years. The closer definition of the genotype appears to leave some of the smaller Grand Tower species of *Microcyclus* without specific names, and this seems to call for additional work on the Grand Tower or "Devil's Backbone" specimens as well as a complete re-examination of much of the Ontario *Microcyclus* material prompted by the large and varied new collection. The results of these studies are given, herewith, in the form of observations on certain of the well-known species and the descriptions of others that are new. Unfortunately, in some cases it has been necessary to use some poorly preserved and fragmentary specimens, but they show such marked differences from other species that it seems advisable to describe them here.

## DISCUSSION OF DESCRIBED SPECIES

### *Microcyclus discus* Meek and Worthen

#### Plate I, figures 1-20

*Microcyclus discus* Meek and Worthen, 1868; Ill. Geol. Surv., vol. 3, Pl. 11, 7a, 7b.

The set of specimens used for this study contains some very good material recently from the type locality at the Devil's Backbone ridge near Grand Tower, Jackson county, Illinois. The size range is from 12 to 22 mm. in diameter and 2 to 4 mm. in thickness. The extremes are perhaps rare.

The general cross-section of the discoid specimen is planoconvex, the under side being more or less flat with the centre depressed in some specimens. The epitheca is well developed, concentrically wrinkled, and thin enough to show the bases of the septa through it. In some of the more typical specimens, the margin thins abruptly to a sharp edge, which may be crimped or crinkled. The attachment scar is usually small, enveloped in the epitheca, or obsolete. The distal side or calyx is usually convex, but flattened and smooth towards the centre, which latter is slightly depressed in some individuals. A specimen 20 mm. in diameter has 24 major septa in addition to the cardinal and 3 in the counter position. The cardinal septum is in a well-defined narrow fossula. The minor septa are generally equal in number to the majors, and they are usually formed in such close association to the major septa as to suggest bifurcation, even trifurcation—terms frequently applied to them. The major septa extend fully two-thirds of the distance from the margin to the centre, and some can be traced much closer to the centre of the disk. This is a strong robust species, and has the characteristics of vigorous growth.

*Occurrence.* The 10 feet of shaly limestone (Lingle limestone) immediately above the Grand Tower limestone at the northern end of Devil's Backbone ridge, Grand Tower, Jackson county, Illinois.

*Microcyclus thedfordensis* Bassler

Plate II, figures 5-23

*Microcyclus thedfordensis* Bassler, 1937; Jour. Pal., vol. 11, pp. 194-195, Pl. 31, figs. 5-9.

This is probably the most abundant species of the whole genus, so far as North America is concerned. The study of its characteristics and peculiarities is based on hundreds of specimens, most of which are nearly perfect. Thin sections and polished surfaces of specimens set in lucite have been prepared and studied, but the essential features are easily observed by the naked eye and with the aid of a hand lens. The species is exceedingly variable. Charles Southworth, who has collected *Microcyclus* in the Thedford-Arkona region for many years, says: "I have examined hundreds of specimens and I must say that no other fossil that I have ever seen shows so many individual differences as do the *Microcyclus*. It is hard to tell where individual differences cease and specific differences begin".<sup>1</sup> This variation applies more or less to all the species of the genus examined when a sufficient number can be assembled for such comparison.

To recount its evident characters, *Microcyclus thedfordensis* Bassler is a small, discoidal coral ranging in diameter from 4 mm. or less to 15 mm. (average, 12 mm.) and in thickness from 1 mm. to 3 mm. but rarely exceeding 2 mm. The under surface is flattened to irregularly convex, with a well-developed epitheca, which is usually thick and strongly marked by concentric growth lines or wrinkles. The extent to which the epitheca is thickened varies with different specimens and seems to be related to the kind and security of the contact made with the supporting object.

<sup>1</sup> Letter of July 9, 1951.

The thin, marginal edge of the epitheca commonly extends beyond the outer ends of the septa, and thus forms a sharp-edged peripheral band that may be turned up and also crimped at the outer margin. The basal side nearly always shows the attachment scar at or near the point of embryonic growth. About 99 per cent of the specimens from the locality at Hungry Hollow, near Arkona, show the scar or some remnant of it, and in many cases the impression of the attachment is so well preserved that specific identification of the host is possible. Specimens not actually showing the scar may preserve evidence of its envelopment by the epitheca. Those in which this overgrowth occurs may exhibit more or less distortion, especially if the object to which it is attached remains embedded. Some individuals show evidence of having been hosts themselves to annelids or other attached and boring organisms. This infestation likewise may have caused distortion of form even within the calyx. *Microcyclus thedfordensis* Bassler may have used as attachment nearly every type of shell or hard part of animal origin, even ostracodes, trilobites, and conodonts, but it seems to have preferred brachiopods, chiefly *Chonetes*. Evidently many of these corals got very little support from attachment, and may not have required it in the adult stage. If the attachment happened to be to a large shell or shell fragment the individual coral may have been dominated or hindered by it throughout life. As some of them were attached to such active animals as trilobites, it is probable that the contact was made to a cast-off fragment of carapace, shell, or tooth on the sea floor, and not to the living individual. If the attachment was made to a crinoid stem, a tentaculite, or similar elongate organic fragment, there usually resulted an elongation of the coral individual with the long axis of such body of attachment, and thus the symmetry of the calyx was disturbed.

Twin forms occur, with the walls in contact vertical and more or less fused. Such twinning appears to have arisen from two embryonic individuals choosing the same attachment location and then proceeding to crowd each other. This would seem to be accidental and neither real twinning nor a tendency to develop a colony, although in some instances there may have been a common wall along that part of the two polyps in contact. In some instances a young individual used a larger or older *Microcyclus* as an attachment. Rejuvenation occurred within the calyx in some of the polyps, thus producing thicker double forms of skeleton, still showing the remnants of the older or parent individual.

Usually the central smooth area, into which the major septa extend, is not only smaller in *Microcyclus thedfordensis* than in *Microcyclus discus* but may be entirely lacking in the lower two quadrants where the septa then extend to the centre of the calyx, and in such specimens the bases of certain septa may be traced through the smooth area nearly to the centre in the upper quadrants adjacent to the cardinal septum. Some individuals show no such smooth area but merely a central compact region composed of the crowded, thickened axial ends of the major septa, some of which can be separately distinguished to the approximate centre of the calyx. Very small specimens, 1 mm. in diameter and apparently belonging to this species, have a total of 12 to 14 septa, of which the 4 primary septa extend to the centre with no evidence of a central smooth area. In well-preserved

adult specimens the whole calyx may have a granular surface, and the granules may be especially prominent in the bottom of the fossula on either side of the cardinal septum.

The upper surface or calyx may flare out into a wide-open cup, with margin turned up, but in other specimens the bottom of the calyx may be so arched or convex upward as literally to turn the cup inside out. In most specimens the cardinal septum may be distinguished in the bottom of a well-developed fossula, and it may extend nearly to the centre of the smooth area. The counter septum appears to be characteristically divided into three, of which the centre one can be seen to be the true counter in some specimens. The alars are rarely pronounced or even identifiable with certainty, but thin sections and polished sections in lucite may show them a little better than whole specimens. The calyx has 20 to 24 major septa and nearly as many minors. The major and minor septa are not symmetrically developed in comparable right and left quadrants, and rarely so even on the same specimen. The upper left quadrant seems more likely to be variable, and this has been observed in other species of the genus. The minor septa, which usually alternate with the majors, may appear free, but are frequently attached to the majors. The major septa are commonly curved or abruptly bent, and the point where this flexure occurs is where the minor septum takes off or to which it may be attached.

Except for a sturdy attachment base, *Microcyclus thedfordensis* is usually a somewhat more delicate form than the genotype, but, as has been stated, it appears to be the more abundant species and has all the characteristics widely known for the genus.

*Occurrence.* The upper 10 to 20 feet of the Arkona shale in the Thedford-Arkona region, Ontario, Canada.

#### *Microcyclus bifidus* Stumm

Plate IV, figures 13-16; Plate VII, figures 2, 3, 4, and 8

*Microcyclus bifidus* Stumm, 1949; Journal of Pal., vol. 23, pp. 507, 508, Pl. 82, figs. 8-10.

The diameter range of the available specimens is from 10 to 16 mm., with an average of 12 mm. Some of them are thin, but the average thickness is about 2 mm. The epitheca is well developed, and shows wrinkles or growth lines about a well-preserved attachment scar. In the calyx, it is difficult to distinguish the primary septa, but generally the cardinal can be identified in the short, definitely impressed fossula, and it usually bears a grooved or bifid edge like that of the other septa. The remaining primaries are much less distinguishable. Apart from the primaries, there are 20 to 24 major septa and usually an equal number of minor septa, all with median grooves. The minor septa are usually free at the axial ends.

The central smooth area is generally very small and likely to be concave, or it may be entirely wanting, with the centre occupied by the butts of some of the major septa that radiate towards the margin. Other specimens may be found with the major septa extending only half-way from margin to centre. It is evident that this is also one of the variable members of the genus, and its limits are difficult to determine.

Some of the specimens available show evidence of having been infested with annelid worms or affected by boring sponges. Many have remnants of overgrowing bryozoa, and a large percentage of the specimens have ostracodes still attached. In fact, the zone of the Arkona shale, in which *Microcyclus* is of common occurrence, is the one already mentioned as heavily loaded with ostracode remains.

*Occurrence.* The upper 10 to 22 feet of the Arkona shale, Thedford-Arkona region, Ontario, Canada.

*Microcyclus erraticus* Stumm

*Microcyclus erraticus* Stumm, 1949; Jour. of Pal., vol. 23, p. 508, Pl. 82, figs. 4-6.

This is probably a rare species, and the genus itself is rare in the Coral zone from which it is reported. In so far as the writer can determine, there are no examples of this species among those in the large collection from the Arkona shale in his possession. Mr. Southworth sent two specimens with the suggestion that they resemble the type, but he doubted whether either were identical with it. This latter opinion is probably correct, and the indicated specimens have been referred to distorted individuals of other species.

*Occurrence.* Coral bed, Hungry Hollow, 2 miles north and  $\frac{3}{4}$  mile east of Arkona, Ontario, Canada.

DESCRIPTIONS OF NEW SPECIES

*Microcyclus canadensis* n.sp.

Plate V, figures 1, 2, and 4-14; Plate VII, figures 12, 24;  
Plate VIII, figures 3, 4

Corallum, a thin disk ranging in diameter from 6 mm. or less to 16 mm.<sup>1</sup> (average, 12 mm.), and in thickness from 1 mm. to 2 mm. (average, about 1.5 mm.). The thinner specimens show very clearly through the epitheca the bases of the more prominent septa extending to the axial centre of the proximal side; the thin epitheca rarely bears evidence of growth lines or wrinkles, although there may be a thickened circle of epitheca about two-thirds of the distance from the centre to the margin, or in a few individuals much nearer the margin. This thickening may extend back to the centre of growth or axis and thus differentiate that part as a circular, central, flat, featureless area, from the marginal rim in which the septa may show almost as plainly as on the top side or calyx. The edge is thin and distinctly crinkled. Many of these specimens are asymmetrical, with the axis and attachment scar definitely off centre.

Calyx or distal side with flat or slightly arched surface; central smooth area medium to small, and usually depressed; fossula short, shallow, and may be nearly filled by the cardinal septum; counter septum the centre of a

<sup>1</sup> Since this report was forwarded for printing, several large specimens of this species have been obtained from the Tile Yard at Thedford, Ontario. The largest of these has a diameter of 21 mm.

group of 3, and the alars not conspicuously developed, commonly indistinguishable; 24 to 28 major septa, and usually with the same or fewer minor septa, which may be attached to the majors although some are free. The wide, flattened septa extend about half-way from margin to centre, but some may be traced well within the central smooth area. The tops of these flattened major septa frequently are marked by 2 to 4 or more nearly parallel raised lines or ridges, which may loop into the edge of the central flattened area; margin thin, occasionally scalloped, and may be slightly turned up. The septa may split at the margin. This is another abundant and variable species. It is a fragile form, usually very thin and easily broken. Many of the specimens have been largely replaced by calcite, which separates easily along crystal faces or planes of cleavage and thus disintegrates.

*Occurrence.* Upper 10 to 22 feet of the Arkona shale in the Thedford-Arkona region of Ontario, Canada.

*Types.* Syntypes, G.S.C. Nos. 10239, 10240, 10242; paratypes, G.S.C. Nos. 10241, 10243, 10244, 10247, 10266.

*Microcyclus crenulatus* n.sp.

Plate III, figures 11-16

Corallum of medium thickness, flattened discoidal or biconvex, with distal side depressed in the centre; diameter, 10 to 14 mm., and the thickness 2.5 to 3 mm.; proximal or under side convex, with a well-marked attachment scar; epitheca thick, and coarsely marked by concentric growth lines or wrinkles; calyx or distal side with a well-developed narrow fossula in which the cardinal septum becomes more prominent towards the outer margin of the calyx. The margin is relatively thin and sharp, but the major septa extend nearly to the outer edge; counter septum not very conspicuous, usually undivided but bordered by 2 equally important major septa, probably representing those that have commonly been referred to in this genus as split from the counter. There are 20 to 24 major septa extending three-quarters or more of the distance from margin to centre. The central flattened area may thus be reduced to near zero. Minor septa are of about the same number, somewhat inconspicuous, mostly free, and rarely extending more than one-quarter of the distance from margin to centre; sides of septa with vertical ribs or ridges and the edges of most septa finely crenate. This feature appears to be more conspicuously developed in the upper quadrants. The entire surface of the calyx is roughly granular.

*Occurrence.* In the upper part of the Arkona shale and especially in the *Microcyclus* lens 22 feet below the top of the formation, Tile Yard, Thedford, Ontario, Canada.

*Types.* Holotype, G.S.C. No. 10228; paratypes, G.S.C. Nos. 19229, 10230.



*Microcyclus grandis* n.sp.

## Plate III, figures 7-10

This species is represented by a fine, complete specimen, 14 mm. in diameter, and by a fragment from the upper left and part of the lower left quadrants of a large specimen probably 24 mm. in diameter, representing one of the larger species of the genus. Both specimens show that the species is nearly circular or slightly elliptical in outline, with a diameter range as indicated above and a thickness of 2 to 3 mm.

The proximal or under side is variable, but is nearly flat to concave, with a thick, coarsely wrinkled epitheca that thins towards the outer margin or edge where the bases of the septa show through rather faintly; attachment scar well marked, partly overgrown or not shown; edge bluntly acute, and may be indistinctly scalloped.

The distal side or calyx is marked by a well-defined, deep, narrow fossula, with a prominent cardinal septum in the bottom. The cardinal septum extends from near the centre of the disk to the margin, and in the available specimens rises abruptly at both ends; alars well developed, and counter undivided; 22 to 24, perhaps more, coarse, smooth major septa, which extend to the very edge of the calyx. Near the centre their bases unite and successive majors thus form a narrow, smooth strip that may be nearly vertical along the deepest part of the fossula. The poorly developed, depressed, central smooth area is mostly in the lower half where the majors are slightly shortened. The minor septa partly fill the marginal part of the interspaces between the majors, with short, knobby ridges rarely showing any definite attachment to the majors.

*Occurrence.* Upper part of Arkona shale at Rock Glen, Arkona, Ontario.

*Types.* Holotype, G.S.C. No. 10226; paratype, G.S.C. No. 10227.

*Microcyclus(?) ignotus* n.sp.

## Plate V, figures 23-25

Corallum, thick, discoidal, 14 mm. in diameter, and 4 mm. thick; proximal or under side irregularly convex, with a strongly marked attachment scar and thickened tissue about it; epitheca rough and coarsely wrinkled, with concentrically arranged growth lines; calyx or distal side flat, with depressed central smooth area; fossula deep, narrow, but slightly expanding as it approaches the axis, near which it terminates abruptly; primary septa scarcely distinguishable except for the cardinal septum, which is short and prominent only in the marginal part of the fossula; about 24 strong, major septa, with the alternating minors short and weakly developed.

The surface of the central area is nearly smooth, but the septa are rough, granular, and may show some striae. The fossula is bounded by a loop-like ridge formed by the adjacent septa. The calyx of the type specimen shows rejuvenation.

*Occurrence.* In the calcareous lens 22 feet below the top of the Arkona shale, Tile Yard, Thedford, Ontario.

*Type.* Holotype, G.S.C. No. 10254.

*Microcyclus laticostatus* n.sp.

Plate IV, figures 3-5; Plate VIII, figures 1, 2

Corallum, circular to somewhat ovate in outline. The slight elongation appears to be in the plane of the cardinal-counter septa, neither of which is very conspicuous; 16 to 18 mm. in diameter and 3.5 mm. thick; base or proximal side uneven, but generally convex and may be flatly pyramidal; epitheca very thin, showing faintly some concentric growth lines near the margin and a depressed concentric ring, doubtless also a marginal growth feature, about one-quarter of the distance from margin to centre. The bases of the septa show clearly; centre raised above the surrounding area and showing no definite attachment scar.

Calyx or distal side slightly convex, depressed in the median area, which is more or less smooth; no distinct fossula shown, and primary septa not clearly distinguishable; 32 to 34 broad major septa, with minor septa poorly developed and attached thereto. Some of the major septa are traceable into the central smooth area; margin sharp, notched, or scalloped, and slightly turned down.

*Occurrence.* In the Arkona shale, 22 feet below top of the formation, Tile Yard, Thedford, Ontario.

*Type.* Holotype, G.S.C. No. 10234.

*Microcyclus macilentus* n.sp.

Plate VI, figures 1-6

Corallum, a thin flattened disk 14 to 18 mm. in diameter and 2 to 2.5 mm. thick; basal or proximal side nearly flat, with a very thin concentric growth-lined epitheca and with a slight attachment scar showing at the centre. The bases of the septa show through the epitheca of most specimens and on some are quite conspicuous. Top and bottom sides are nearly parallel, and meet at the margin, usually forming a blunt edge, although some specimens show an extended thin edge.

Calyx with fossula nearly obsolete; cardinal septum narrow and, like the counter, not prominent; alars easily distinguishable but not large; 26 to 34 rather narrow, sharp-edged major septa, with minors attached and interspaces striate on some specimens; central smooth area small, with the major septa extending half-way or more from the margin to centre.

*Occurrence.* In the 10 feet of shaly limestone (Lingle limestone) immediately above the Grand Tower limestone in the old quarry at the northern end of Devil's Backbone ridge, Grand Tower, Jackson county, Illinois.

*Types.* Syntypes, G.S.C. Nos. 10255, 10256.

*Microcyclus microdiscus* n.sp.

Plate II, figures 1-4; Plate IV, figures 6-8; Plate VIII, figures 5-7

Corallum, thin, medium to fairly thick, discoidal, flattened on one or both proximal and distal sides. The edge may be thin or the top side may curve abruptly downward at the margin to meet the flattened base, thus

forming a sharp edge. The size of the species ranges from 9 to 12 mm. or possibly more in diameter and 1.5 to 3 mm. in thickness. Usually the under or proximal side is nearly flat to slightly concave, with the thin epitheca concentrically wrinkled and with some of the septal bases showing through, especially near the margin. The attachment scar may be inconspicuous or largely overgrown by envelopment in the epitheca, and is probably rarely prominent.

The calyx or distal side has a short, moderately impressed or nearly obsolete fossula. The cardinal septum is short, and nearly fills the outer part of the fossula. The counter is in the middle of a group of 3 similar septa where they leave the plain, smooth, central area. In addition to the cardinal and counter there are 16 to 18, possibly 20, major septa that usually extend about half-way from the margin to the centre, but in the upper quadrants they may be traced almost to the centre of the disk. Many of the major septa seem to bifurcate near the outer ends to form the minor septa, although some are entirely distinct. Striations may be detected on some of the septa of well-preserved specimens, but they do not appear to be an essential feature. The central, smooth area of the calyx may be mostly confined to the lower half; it is nearly flat, but the whole distal part gives the impression of flattened convexity.

This is one of the smaller species occurring with the genotype, and the type is from Illinois, but some of the *Microcyclus* from Ontario have a similar septal count, 20, and resemble this species in general, so that it is difficult to separate them. These Canadian specimens are referred to this species although they may be distinct.

*Occurrence.* In the 10 feet of shaly limestone (Lingle limestone) immediately overlying the Grand Tower limestone at Devil's Backbone ridge, Grand Tower, Jackson county, Illinois, and possibly in the upper part of the Arkona shale at Thedford and Arkona, Ontario.

*Types.* Holotype, G.S.C. No. 10235; paratype, G.S.C. No. 10273.

*Microcyclus ontarioensis* n.sp.

Plate V, figures 3 and 15-22; Plate VII, figures 16, 20; Plate VIII, figures 8-15

Corallum, circular in outline, thin, planoconvex to concavoconvex, with thickness ranging from 1.5 to 2 mm. and the diameter from 8 to 10 mm.; basal or proximal side varies from nearly flat to slightly concave; epitheca fairly well developed to thin, and showing faintly the concentric growth lines. The bases of the septa usually show through the epitheca, especially near the margin, and most of the specimens available have a well-developed attachment scar.

Calyx or distal side slightly convex, with depressed central smooth area and a small but distinctly impressed fossula bearing the cardinal septum in the bottom. The counter septum is in the middle of a group of 3 opposite the cardinal. The alars are usually quite conspicuous, thus easily distinguishing upper from lower quadrants and this species from *Microcyclus canadensis*, to which it seems rather closely related. There are about 20 major septa extending two-thirds of the way from margin to

centre, and the short minors are attached to them. The major septa are shorter in the lower half, thus dropping more than half of the smooth area into the lower quadrants. The septa are broad and are sculptured by several longitudinal grooves, with ridges between. Usually this sculpturing may be traced into the central smooth area, where the ridges tend to form loops.

This is one of the very fragile forms, easily crushed and broken, so that whole specimens do not appear to be abundant.

*Occurrence.* In the upper part of the Arkona shale at Thedford and Arkona, Ontario.

*Types.* Holotype, G.S.C. No. 10248; paratypes, G.S.C. Nos. 10240, 10249-10252.

*Microcyclus planoconvexus* n.sp.

Plate VI, figures 7-9

Corallum 14 mm. in diameter and 3.5 to 4 mm. thick; basal side flat, with a thin concentrically wrinkled epitheca through which the bases of the septa show, and more clearly near the margin; calyx or top side highly arched, especially on the central smooth area, which is distinctly delimited by the abrupt ending of the septa slightly less than half-way from margin to centre; fossula poorly shown or obsolete, and cardinal septum, together with the other primary septa, difficult to distinguish; about 32 short and broad major septa that may be striate and usually divide near the margin to form the minors; margin slightly extended and rather sharp edged.

*Occurrence.* In the lower part of the shaly limestone (Lingle limestone) lying just above the Grand Tower limestone in the old quarry at the north end of Devil's Backbone ridge, Grand Tower, Jackson county, Illinois.

*Type.* Holotype, G.S.C. No. 10257.

*Microcyclus (?) sinuatus* n.sp.

Plate IV, figures 9-12

Corallum, circular to subquadrangular in outline, flattened, but transversely arched slightly upward and broadly undulating or furrowed on the under side, with no attachment scar showing; diameter about 16 mm. and thickness 3 mm.; proximal side with a thin epitheca marked by a pattern corresponding more or less with the bases of the septa, and the epitheca itself showing several halting stages in its marginal growth.

Calyx, with a small, plain, smooth area into the outer margin of which the major septa extend. The only specimen is a fragment that may not show or suggest all its characteristics, but no distinct fossula can be observed. The cardinal septum is not well marked, but is probably small; 16 to 18 major septa; minor septa poorly developed and more or less incorporated into the outer ends of the major septa to form the compound or variously divided septa that extend beyond the margin to form a jagged edge.

*Occurrence.* In the *Microcycles* lens 22 feet below the top of the Arkona shale, Tile Yard, Thedford, Ontario.

*Type.* Holotype, G.S.C. No. 10236.

*Microcyclus southworthi* n.sp.

Plate III, figures 1-6; Plate VII, figure 1

This species is represented by two, fine, complete specimens and the right half of another equally fine specimen. They show a corallum varying from 14 to 22 mm. in diameter and 1.5 to 2.5 mm. in thickness. The under or proximal side is flat or slightly concave, and is covered by a well-developed, concentrically wrinkled epitheca. Like flattened radiating ridges, the bases of the septa may be seen through the epitheca, especially near the margin where the epitheca itself is thinner and the outer edge is roundly to roughly scalloped under the influence of the projecting outer ends of the septa. This outer edge may be turned abruptly downward.

The calyx or distal side is flattened to slightly concave in the central smooth area, but the outer border, where the septa are especially well developed, bends rapidly downward to produce the overall convexity more or less common for the genus. There may be a well-developed, moderately depressed fossula, with the cardinal septum extending down its depressed axis and disappearing into the smooth or flattened area at or near the centre of the calyx where the fossula ends. In the larger of the complete specimens, the primary septa are difficult to identify and the fossula is almost obsolete, but this specimen required much removal of foreign material from the calyx and that region was badly injured. There are 26 to 32 or more strongly developed major septa, most of which extend one-half to two-thirds of the distance from the margin to centre of the calyx and are still traceable within the flattened central area. Some of the minor septa are definitely independent; others are formed in the marginal zone by bifurcation of major septa; further division may then take place, with the outer ends extending to the extreme edge of the calyx. The minor septa are fewer in number than the major septa, but usually show some attachment thereto. The counter septum does not appear to be very different from the major septa, but the alars are slightly more conspicuous. The left quadrants are only partly symmetrical with those on the right. The septa of the upper quadrants appear to trend rather conspicuously upward away from the alars, and unite at their bases to extend the smooth area well up along the margins of the fossula. The surface of the calyx is finely granular over both smooth area and septa. Although the typical outline of the calyx margin is probably circular, or nearly so, the specimens available show an elongation along one diameter, thus giving a more or less ovoid or egg-shaped outline. The larger complete specimen and the fragmentary specimen were attached to pelecypods. The attachment scar is very strongly impressed and well preserved on both of these specimens. The third specimen is still partly embedded in the rock.

*Occurrence.* In the upper part of the Arkona shale, 10 to 20 feet below the base of the Widder beds, at Hungry Hollow and Frazer's farm, near Arkona, Ontario.

*Types.* Holotype, G.S.C. No. 10259; paratypes, G.S.C. Nos. 10224, 10225.

*Microcyclus striolatus* n.sp.

Plate III, figures 17-20; Plate IV, figures 1, 2; Plate VII, figures 5-7, 9-11, 13-15; Plate VIII, figure 16

Corallum, circular, ranging from 6 mm. or less to 15 mm. in diameter and from the small thin specimens of less than 1 mm. to about 2 or 3 mm. in thickness; base or proximal side nearly flat or slightly convex, with well-developed, concentrically wrinkled epitheca, which may show faintly some of the septal bases through it and which has a fairly well-developed attachment scar. The proximal and distal faces usually meet in an abruptly formed edge.

Calyx or top side flattened convex, with the central smooth area slightly depressed at the centre; fossula fairly well developed and variable, but usually extending to about the axial centre, near which it is generally deepest and widest. At mid-length, or near it, the fossula may taper abruptly and become very narrow from there to the margin. The cardinal septum extends along the bottom of the fossula and approximately fills it near the margin; the counter septum apparently splits into 3 at or near the outer limit of the central smooth area, and the alars are rarely distinguishable. There are 24 to 28 major septa, usually extending about two-thirds of the distance from margin to centre. In some specimens the axial ends of certain major septa extend well in towards the centre, commonly obliterating the smooth area entirely; outer ends of the septa flush with the marginal edge, but the latter may show a slight notch at that point; minor septa about half the length or less and generally attached to the major septa, but a few may be free. The sides and top of all the septa are striated, but more prominently so on the top, from which the striae may be traced, in some specimens, into the central smooth area. Although these striae usually parallel the septa, they may cross over from one side to the other, thus occasionally being diagonal. These marks vary from faint striae, which can be seen with difficulty, to well-defined lines easily visible to the naked eye, and usually more plainly shown near the outer ends of the septa. The corresponding quadrants are similar, perhaps more so than is usual in this genus, but they are not exact rights and lefts nor mirror images of each other.

*Occurrence.* In the upper 10 to 20 feet of the Arkona shale at Rock Glen, Arkona, and other outcrops of that vicinity in Ontario.

*Types.* Holotype, G.S.C. No. 10231; paratypes, G.S.C. Nos. 10263-10265, 10278.

*Microcyclus ventricosus* n.sp.

Plate VI, figures 10-12

Outline of corallum circular, 14 mm. in diameter and 6 mm. thick; cross-section rather highly convex on both sides; basal or proximal side with a thin epitheca showing growth lines concentrically arranged but not concentrated into distinct wrinkles; basal attachment not shown, or covered by matrix. Some of the septal bases show through faintly near the margin. The under surface meets the top at a high angle, producing a distinct edge.

The calyx or top side is more highly convex in the centre, and flattens abruptly, turning slightly upward, at the margin. A small, short, and inconspicuous fossula, with a very short cardinal septum developed in the bottom of the fossula; 20 to 22 narrow, sharp-edged major septa are formed, and extend scarcely half-way from margin to centre, which appears to be a smooth area. Minor septa are short, inconspicuous, and attached to the major septa; both may be divided again at the margin.

*Occurrence.* In the 10 feet of shaly limestone (Lingle limestone) immediately overlying the Grand Tower limestone at the northern end of Devil's Backbone ridge, Grand Tower, Jackson county, Illinois.

*Type.* Holotype, G.S.C. No. 10258.

*Microcyclus venustus* n.sp.

Plate VII, figures 17-19, 21-23

Corallum, almost a perfect circle in outline; top and bottom sides flattened, nearly parallel, or if one side is convex the other appears to be concave at a corresponding point; diameter from 9 to 12 mm. and thickness from 1.5 to 2.0 mm.; margin usually thick, but may have a slightly developed edge.

Proximal or basal side flat, slightly concave or even slightly convex; epitheca thin, concentrically wrinkled, and may be radially marked or sculptured by septal bases or the proximal edges of the septa showing through it. There is a well-developed attachment scar.

Calyx or distal side with a depressed but poorly defined fossula marked by a well-developed cardinal septum; counter septum not very distinctive, and alars not differing appreciably from the major septa. The central smooth area is somewhat depressed, and may show the inner ends of the septa fading into it; surface slightly granular. There are 18 to 22 major septa, and an equal number of intimately associated minor septa, all extending to the margin of the calyx. The outer ends of the septa may split, and this tendency seems to be more prevalent in the right side. The major septa extend slightly more than half-way from margin to centre.

*Occurrence.* Upper part of the Arkona shale, Tile Yard, Thedford, Ontario.

*Types.* Syntypes, G.S.C. Nos. 10268, 10270.

## BIBLIOGRAPHY

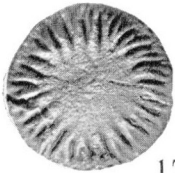
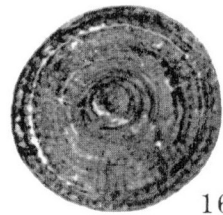
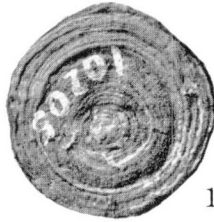
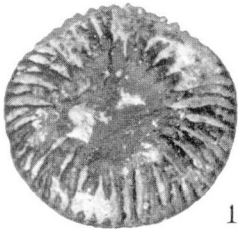
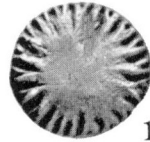
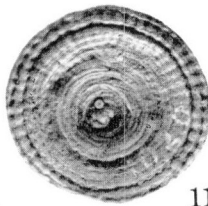
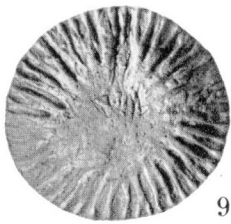
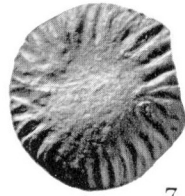
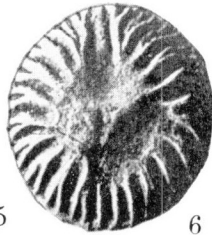
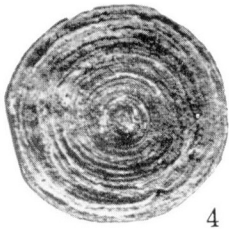
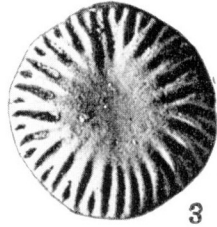
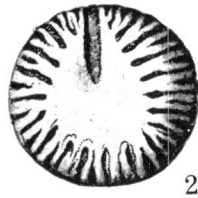
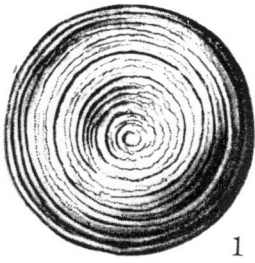
1. Bassler, R. S. (1937): The Paleozoic Rugose Coral Family, Paleocyclidæ; Jour. of Pal., vol. II, pp. 189-201, Pls. 30-32 (*Microcyclus* on pp. 193-196, Pl. 31, figs. 1-18 and 23, 24).
2. ——— (1950): Faunal Lists and Descriptions of Palaeozoic Corals; Geol. Soc. Am., Mem. 44, 315 pp., 20 Pls. (*Microcyclus* listed on pp. 152, 161, etc.).
3. Cooper, G. Arthur (1941): New Middle Devonian Stratigraphic Names; Jour. Wash. Acad. Sci., vol. 31, pp. 259-260.
4. Cooper, G. Arthur, and Warthin, Alfred Scott (1942): New Devonian (Hamilton) Correlations; Bull. Geol. Soc. Am., vol. 53, pp. 873-888.
5. Cooper, G. Arthur, *et al.* (1942): Correlation of the Devonian Sedimentary Formations of North America; Bull. Geol. Am., vol. 53, pp. 1729-1793.
6. Eastman, Charles R., and Vaughn, T. Wayland, collaborator (1913): Coelenterata-Anthozoa; Textbook of Paleontology (Translation and Adaptation from Karl A. Von Zittel), vol. 1, 2nd Edition, p. 82, fig. 106.
7. Grabau, Amadeus W., and Shimer, Henry W. (1910): Anthozoa; North American Index Fossils, vol. I, p. 65, fig. 98.
8. Lambe, Lawrence M. (1900): A Revision of the Genera and Species of Canadian Paleozoic Corals; Contr. to Canadian Palaeontology, vol. 4, pt. 2, p. 107.
9. Meek, B. F., and Worthen, A. H. (1868): Fossils of the Hamilton Group; Illinois Geol. Surv., vol. 3, p. 420, Pl. 11, figs. 7a, 7b.
10. Miller, S. A. (1889): Paleozoic Fossils; North American Geology and Paleontology, p. 196, fig. 194.
11. Nicholson, H. A. (1874): Corals of the Corniferous and Hamilton Formation; Pal. of the Province of Ontario, Sess. Paper No. 6, pp. 38-39, text figs. 9a, 9b.
12. Savage, T. E. (1920): The Devonian Formations of Illinois; Am. Jour. Sci., 4th ser., vol. 49, pp. 169-182.
13. Sherzer, W. H. (1891): A Chart of the Rugose Corals; Am. Geol., vol. 7, pp. 273-301 (*Microcyclus discus* M. and W. listed only on p. 278).
14. Shimer, Hervey W., and Shrock, Robert R. (1944): Coelenterata-Anthozoa; Index Fossils of North America, p. 85, Pl. 23, figs. 15-23.
15. Stauffer, Clinton R.: The Devonian of Southwestern Ontario; Geol. Surv., Canada, Mem. 34, pp. 158, 165, and 230 (*Microcyclus discus* M. and W. listed only).
16. Stumm, Edwin C. (1949): Three new Devonian Species of *Microcyclus* from Michigan and Ontario; Jour. Pal., vol. 23, pp. 507-509, Pl. 82, figs. 8-10.
17. ——— (1949): Revision of Families and Genera of Devonian Tetracorals; Geol. Soc. Am., Mem. 40, 92 pp., 25 Pls. (*Microcyclus* on pp. 6 and 59, Pl. 2, figs. 8-15).
18. Whiteaves, J. F. (1889): List of Fossils from the Hamilton Formation of Ontario; Contr. to Canadian Palaeontology, vol. 1, pt. 2, p. 120 (*Microcyclus discus* M. and W. listed only).



## PLATE I

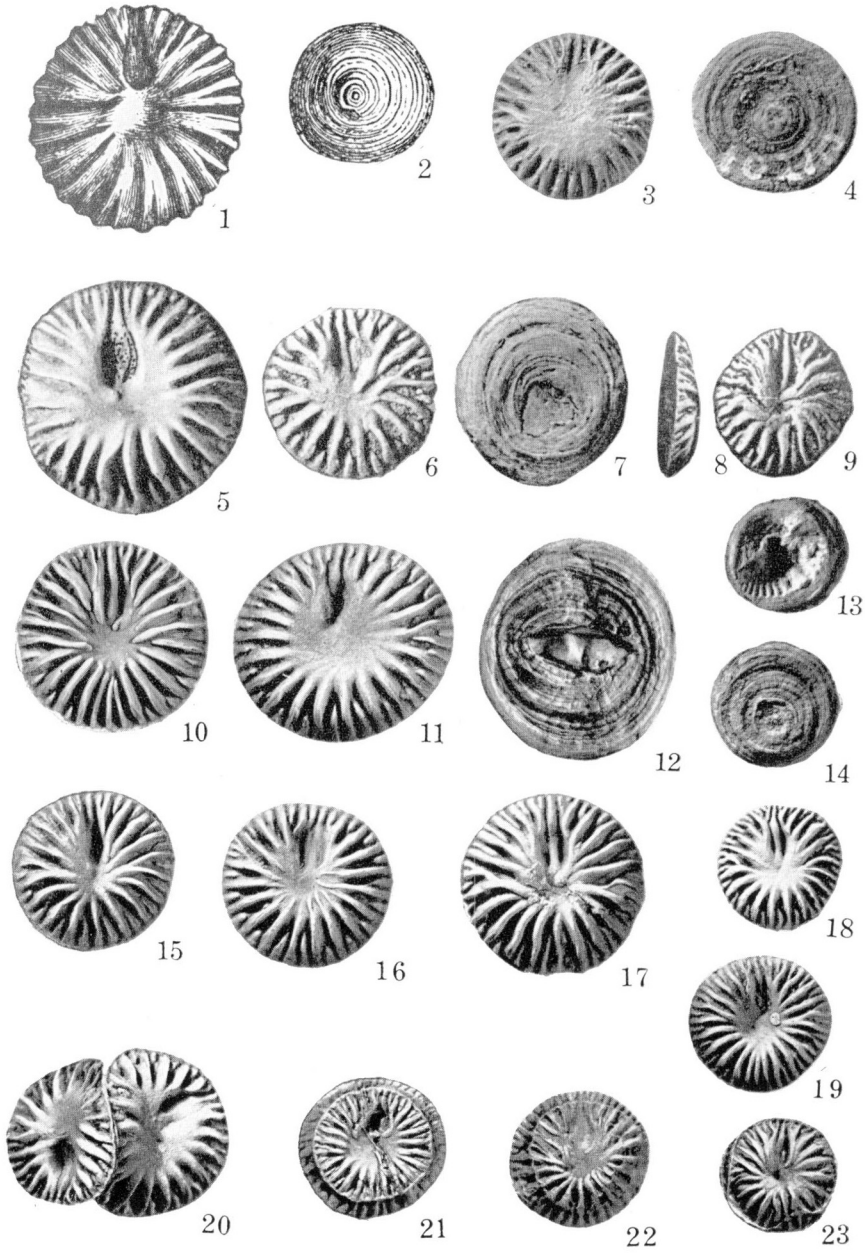
(The indicated enlargements for these plates are approximate)

- Figures 1, 2. *Microcyclus discus* Meek and Worthen; copies of bottom and top views of the type specimens (Ill. Geol. Surv., vol. III, 1868, Pl. XI, figs. 7a, 7b) x  $1\frac{1}{8}$ . From the type locality, "Devil's Backbone", Grand Tower, Jackson county, Illinois. (Page 4.)
- Figures 3-6. *Microcyclus discus* Meek and Worthen; copies of top, bottom, and edge views of Bassler's specimens (Jour. of Pal., vol. XI, 1937, Pl. 31, figs. 1-4) x  $1\frac{1}{8}$ . From the type locality, Grand Tower, Jackson county, Illinois. (Page 4.)
- Figures 7, 8. *Microcyclus discus* Meek and Worthen; top and edge views of a medium-sized specimen from the type locality, Grand Tower, Jackson county, Illinois. G.S.C. No. 10201, x  $1\frac{1}{2}$ . (Page 4.)
- Figures 9-11. *Microcyclus discus* Meek and Worthen; top, edge, and bottom views of a large, well-preserved specimen from the type locality, Grand Tower, Jackson county, Illinois. G.S.C. No. 10202, x  $1\frac{1}{2}$ . (Page 4.)
- Figures 12, 13. *Microcyclus discus* Meek and Worthen; top and lateral or edge views of a small specimen from the Lingle limestone, at the type locality, Grand Tower, Jackson county, Illinois. G.S.C. No. 10203, x  $2\frac{1}{2}$ . (Page 4.)
- Figures 14-16. *Microcyclus discus* Meek and Worthen; top and bottom views of three different specimens of large size from the type locality, Grand Tower, Jackson county, Illinois. G.S.C. Nos. 10204-10206, x  $1\frac{1}{2}$ . (Page 4.)
- Figures 17, 18. *Microcyclus discus* Meek and Worthen; top and bottom views of a thin-edged medium-sized specimen from the type locality, Grand Tower, Jackson county, Illinois. G.S.C. No. 10207, x  $1\frac{1}{2}$ . (Page 4.)
- Figures 19, 20. *Microcyclus discus* Meek and Worthen; top views of two small specimens from the type locality, Grand Tower, Jackson county, Illinois. G.S.C. Nos. 10208-10209, x  $1\frac{1}{2}$ . (Page 4.)



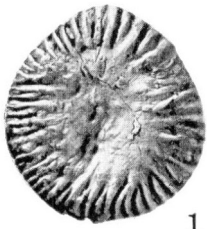
## PLATE II

- Figures 1, 2. *Microcyclus discus* (?) Meek and Worthen (H. A. Nicholson, Pal. of Ontario, Sess. Paper No. 6, 1874, p. 38, figs. 9a, 9b). Copy of Nicholson's illustrations of the specimen, which he obtained at Bartlett's Mills (Marsh's Mill or Hungry Hollow), near Arkona, Ontario, and identified by him as the Meek and Worthen species. It is probably the same as figures 3 and 4 of this plate, which are of a specimen from the same locality. Top side, x 2½; bottom side, x 1½. (Page 11.)
- Figures 3, 4. *Microcyclus microdiscus* (?) n.sp.; top and bottom views of a specimen from the upper part of the Arkona shale, Hungry Hollow, Ontario (See also Pl. IV, fig. 6). G.S.C. No. 10210, x 2. (Page 11.)
- Figures 5-9. *Microcyclus thedfordensis* Bassler; copies of top, bottom, and edge views of type specimens (Jour. of Pal., vol XI, 1937, Pl. 31, figs 5 to 9), x 2½. (Page 5.)
- Figure 10. *Microcyclus thedfordensis* Bassler; top view of a specimen from the Arkona shale, Tile Yard, Thedford, Ontario. G.S.C. No. 10211, x 2. (Page 5.)
- Figures 11, 12. *Microcyclus thedfordensis* Bassler; top and bottom views of a specimen from the Arkona shale, Hungry Hollow, near Arkona, Ontario. G.S.C. No. 10212, x 2. (Page 5.)
- Figure 13. *Microcyclus thedfordensis* Bassler; bottom view of a specimen showing attachment to a small *Mucrospirifer*, Arkona shale, Hungry Hollow, Ontario. G.S.C. No. 10213, x 1¼. (Page 5.)
- Figure 14. *Microcyclus thedfordensis* Bassler; bottom view of a specimen showing attachment to a small shell fragment; Arkona shale, Hungry Hollow, Ontario. G.S.C. No. 10214, x 1¼. (Page 5.)
- Figure 15. *Microcyclus thedfordensis* Bassler; top view of a specimen showing marginal rim extending beyond the outer ends of the septa; Arkona shale, Hungry Hollow, Ontario. G.S.C. No. 10215, x 2. (Page 5.)
- Figures 16, 17. *Microcyclus thedfordensis* Bassler; top views of two specimens from the Arkona shale, Rock Glen, Arkona, Ontario. G.S.C. Nos. 10216-10217, x 2. (Page 5.)
- Figures 18, 19. *Microcyclus thedfordensis* Bassler; top views of two specimens from the Arkona shale, Hungry Hollow, Ontario. G.S.C. Nos. 10218-10219, x 1¼. (Page 5.)
- Figure 20. *Microcyclus thedfordensis* Bassler; top view of twins from the Arkona shale, 15 feet below the top, Rock Glen, Arkona, Ontario. G.S.C. No. 10220, x 2½. (Page 5.)
- Figures 21, 22. *Microcyclus thedfordensis* Bassler; top views of two specimens showing rejuvenation; Arkona shale, Hungry Hollow, Ontario. G.S.C. Nos. 10221-10222, x 1½. (Page 5.)
- Figure 23. *Microcyclus thedfordensis* Bassler; top view of a specimen showing turned up rim or margin; Arkona shale, Hungry Hollow, Ontario. G.S.C. No. 10223, x 1½. (Page 5.)



## PLATE III

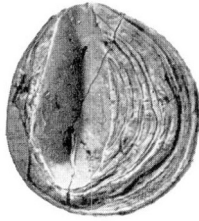
- Figures 1-3. *Microcyclus southworthi* n.sp. Paratype. G.S.C. No. 10224, x  $1\frac{1}{2}$ . Top, edge, and bottom views of a specimen collected by Mrs. Charles Southworth in the upper part of the Arkona shale, Hungry Hollow, Ontario. (Cardinal septum partly destroyed by vigorous removal of ostracodes from central smooth area.) (Page 14.)
- Figures 4-6. *Microcyclus southworthi* n.sp. Paratype G.S.C. No. 10225, x  $1\frac{1}{2}$ . Top, edge, and bottom views of fragmentary specimen collected by Mr. Charles Southworth from the same horizon and probably the same locality as the above. (*See also* Pl. VII, fig. 1.) (Page 14.)
- Figures 7-9. *Microcyclus grandis* n.sp. Holotype. G.S.C. No. 10226, x  $1\frac{1}{2}$ . Top, edge, and bottom views of type specimen from the Arkona shale, Rock Glen, Arkona, Ontario. (Page 10.)
- Figure 10. *Microcyclus grandis* n.sp. Paratype, G.S.C. No. 10227, x  $1\frac{1}{2}$ . A fragment of a larger specimen from the same horizon and locality as the holotype. (Page 10.)
- Figures 11-13. *Microcyclus crenulatus* n.sp., Holotype, G.S.C. No. 10228, x  $2\frac{1}{2}$ . Top, edge, and bottom views of the type specimen from the Arkona shale, Tile Yard, Thedford, Ontario. (Page 9.)
- Figures 14, 15. *Microcyclus crenulatus* n.sp. Paratype, G.S.C. No. 10229, x  $2\frac{1}{2}$ . Top and bottom views of another specimen from the Arkona shale, 22 feet below its top, Tile Yard, Thedford, Ontario. (Page 9.)
- Figure 16. *Microcyclus crenulatus* n.sp. Paratype, G.S.C. No. 10230, x  $2\frac{1}{2}$ . Top view of a broken specimen from the Arkona shale, 22 feet below its top, Tile Yard, Thedford, Ontario. (Page 9.)
- Figures 17, 18. *Microcyclus striolatus* n.sp. Holotype, G.S.C. No. 10231, x  $1\frac{1}{2}$ . Top and bottom views of type specimen from the Arkona shale, Rock Glen, Arkona, Ontario. (*See also* Pl. IV, fig. 1.) (Page 15.)
- Figures 19, 20. *Microcyclus striolatus* n.sp. Top and bottom views of a specimen from the Arkona shale, Rock Glen, Arkona, Ontario. G.S.C. No. 10232, x 2. (Page 15.)



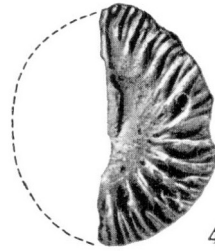
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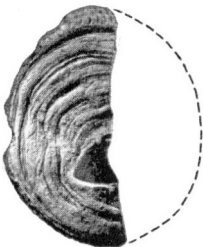
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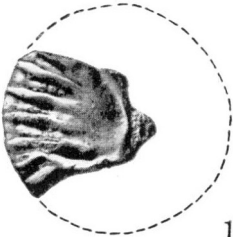
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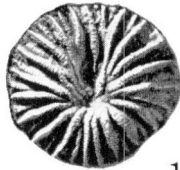
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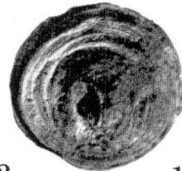
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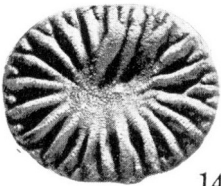
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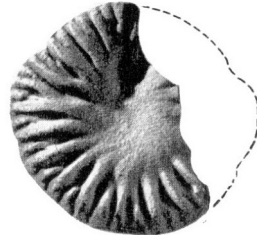
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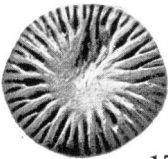
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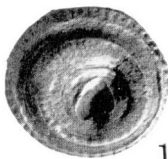
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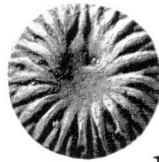
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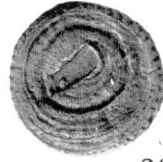
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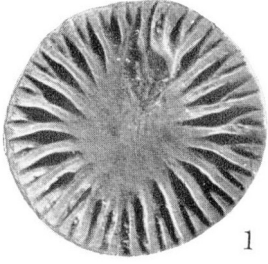
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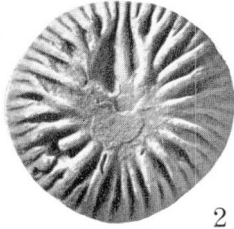
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## PLATE IV

- Figure 1. *Microcyclus striolatus* n.sp. Holotype, x 2½. Top view of the type specimen from the Arkona shale, Rock Glen, Arkona, Ontario. (See also Pl. III, figs. 17, 18.) (Page 15.)
- Figure 2. *Microcyclus striolatus* n.sp. Paratype, G.S.C. No. 10233. Top view of another specimen from the Arkona shale, Rock Glen, Arkona, Ontario. (Page 15.)
- Figures 3-5. *Microcyclus laticostatus* n.sp. Holotype, G.S.C. No. 10234, x 2½. Top, edge, and bottom views of the type specimen from the calcareous lens 22 feet below the top of the Arkona shale, Tile Yard, Thedford, Ontario. (See Pl. VIII, figs. 1, 2.) (Page 11.)
- Figure 6. *Microcyclus microdiscus* (?) n.sp. x 2½. Top view of a specimen from the Arkona shale, Hungry Hollow, Ontario. (See also Pl. II, figs. 3 and 4.) (Page 11.)
- Figures 7, 8. *Microcyclus microdiscus* n.sp. Holotype, G.S.C. No. 10235, x 2½. Top and bottom views of the type specimen from the *Microcyclus* zone of the Lingle limestone, Grand Tower, Jackson county, Illinois. (Page 11.)
- Figures 9-11. *Microcyclus* (?) *sinuatus* n.sp. Holotype, G.S.C. No. 10236, x 2½. Top, edge, and bottom views of the type specimen from the calcareous lens 22 feet below top of the Arkona shale, Tile Yard, Thedford, Ontario. (Page 13.)
- Figure 12. *Microcyclus* (?) *sinuatus* n.sp. Holotype, G.S.C. No. 10236, x 2. A camera-lucida drawing of same top view as fig. 9. (Page 13.)
- Figures 13, 14. *Microcyclus bifidus* Stumm. Copies of top and edge views of the type specimen, x 2. (Jour. of Pal., vol. 23, 1949, Pl. 82, figs. 8, 9.) (Page 7.)
- Figure 15. *Microcyclus bifidus* Stumm. G.S.C. No. 10237, x 1¼. Top view of a specimen from the Arkona shale, Hungry Hollow, Ontario. (Page 7.)
- Figure 16. *Microcyclus bifidus* Stumm. G.S.C. No. 10238, x 2½. Top view of a specimen from the calcareous lens 22 feet below the top of the Arkona shale, Tile Yard, Thedford, Ontario. (Page 7.)



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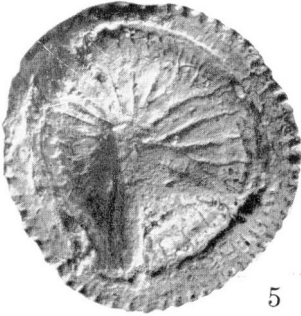
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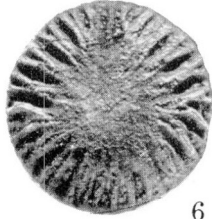
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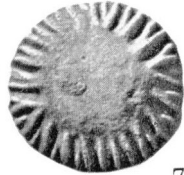
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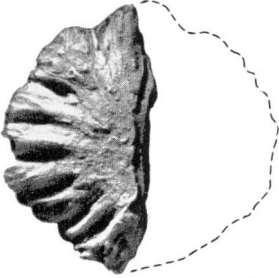
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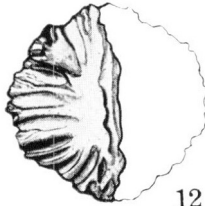
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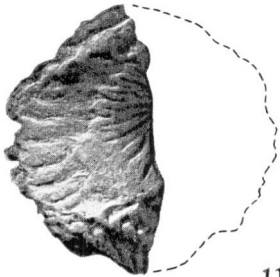
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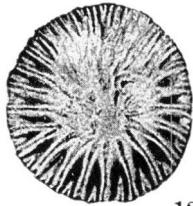
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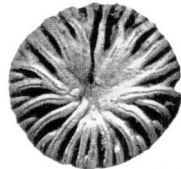
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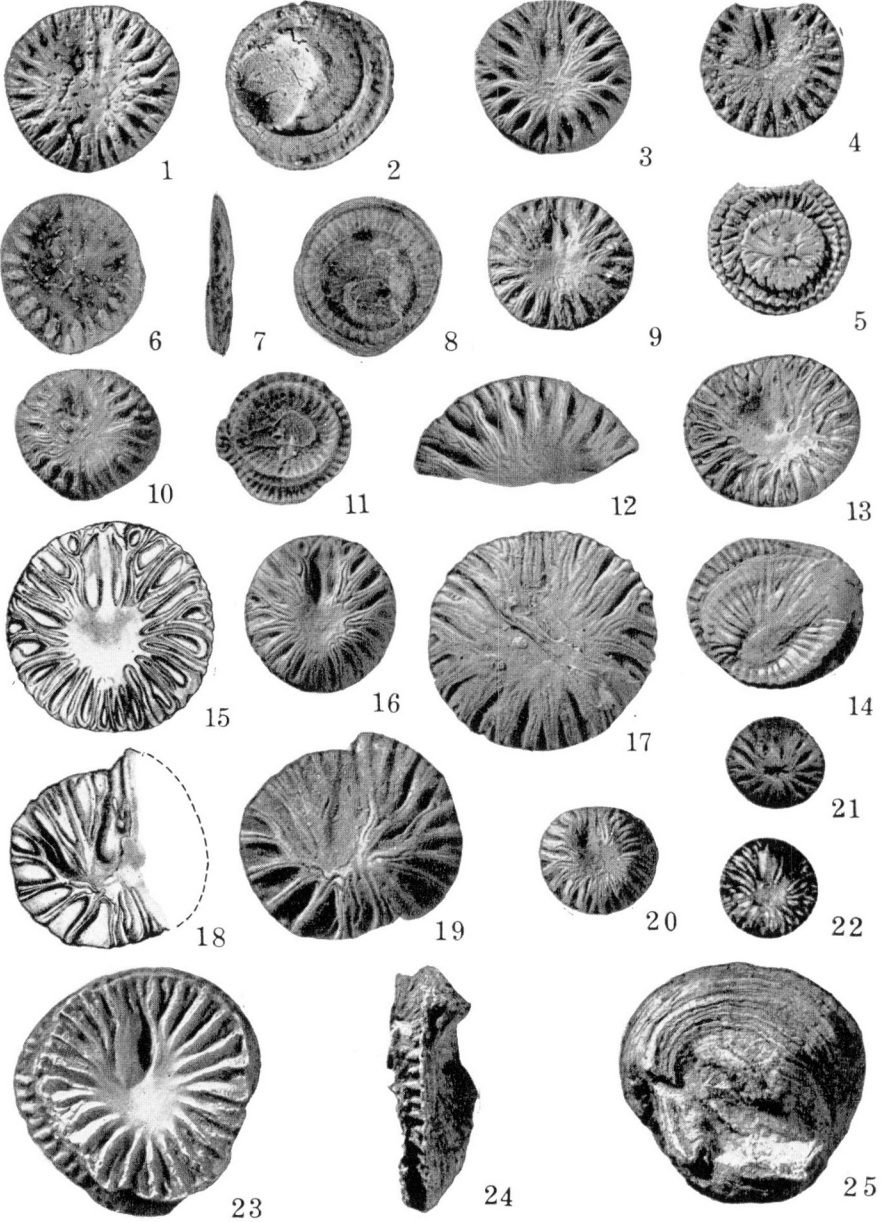


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## PLATE V

- Figures 1, 2. *Microcyclus canadensis* n.sp. Syntype, G.S.C. No. 10239, x 1½. Top and bottom views of a specimen from the upper part of the Arkona shale, Hungry Hollow, Ontario. (Page 8.)
- Figure 3. *Microcyclus ontarioensis* n.sp. Paratype, G.S.C. No. 10240, x 2. Top view of a specimen from the upper part of the Arkona shale, Rock Glen, Arkona, Ontario. (See also Pl. VIII, figs. 10 and 11 for same specimen.) (Page 12.)
- Figures 4, 5. *Microcyclus canadensis* n.sp. Paratype, G.S.C. No. 10241, x 1½. Top and bottom views of a specimen from the upper part of the Arkona shale, Tile Yard, Thedford, Ontario. (Page 8.)
- Figures 6-8. *Microcyclus canadensis* n.sp. Syntype, G.S.C. No. 10242, x 1½. Top, edge, and bottom views of a specimen from the thin calcareous lens 22 feet below the top of the Arkona shale, Tile Yard, Thedford, Ontario. (Page 8.)
- Figures 9, 10. *Microcyclus canadensis* n.sp. Paratypes, G.S.C. Nos. 10243, 10244, x 1½. Top views of two specimens from the thin calcareous lens 22 feet below top of the Arkona shale, Tile Yard, Thedford, Ontario. (Page 8.)
- Figure 11. *Microcyclus canadensis* n.sp. G.S.C. No. 10245, x 1½. Bottom view of a specimen from the upper part of the Arkona shale, Hungry Hollow, Ontario. (Page 8.)
- Figure 12. *Microcyclus canadensis* n.sp. G.S.C. No. 10246, x 2½. Top view of a well-preserved fragmentary specimen from the Arkona shale, Tile Yard, Thedford, Ontario. (Page 8.)
- Figures 13, 14. *Microcyclus canadensis* n.sp. Paratype, G.S.C. No. 10247, x 1½. Top and bottom views of a specimen from the Arkona shale, Tile Yard, Thedford, Ontario. (Page 8.)
- Figure 15. *Microcyclus ontarioensis* n.sp. Holotype, G.S.C. No. 10248, x 3. Camera-lucida drawing of the top side of the holotype from 15 feet below top of the Arkona shale, Rock Glen, Arkona, Ontario. (Page 12.)
- Figure 16. *Microcyclus ontarioensis* n.sp. Holotype, x 2½. Photograph of top side of same specimen as that in figure 15. (Page 12.)
- Figure 17. *Microcyclus ontarioensis* n.sp. Paratype, G.S.C. No. 10249, x 2½. Top view of a specimen from Arkona shale, Stephens farm, Thedford, Ontario. (See also Pl. VIII, fig. 15.) (Page 12.)
- Figure 18. *Microcyclus ontarioensis* n.sp. Paratype, G.S.C. No. 10250, x 2½. Camera-lucida drawing of the top side of a distorted specimen from the Arkona shale, Tile Yard, Thedford, Ontario. (Page 12.)
- Figure 19. *Microcyclus ontarioensis* n.sp. Paratype, x 2½. Photograph of top side of same specimen as that in figure 18, above. (See also Pl. VIII, fig. 12, for same specimen.) (Page 12.)
- Figures 20-22. *Microcyclus ontarioensis* n.sp. Paratypes, G.S.C. Nos. 10251-10253, x 1½. Top views of three small specimens from the upper part of the Arkona shale, Hungry Hollow, Ontario. (Page 12.)
- Figures 23-25. *Microcyclus (?) ignotus* n.sp. Holotype, G.S.C. No. 10254, x 2½. Top, edge, and bottom views of the type specimen from the thin calcareous lens 22 feet below the top of the Arkona shale, Tile Yard, Thedford, Ontario. (Page 10.)



## PLATE VI

- Figures 1-3. *Microcyclus macilentus* n.sp. Syntype, G.S.C. No. 10255, x  $2\frac{1}{2}$ . Top, edge, and bottom views of a specimen from the *Microcyclus* zone of the Lingle limestone, Grand Tower, Jackson county, Illinois. (Page 11.)
- Figures 4-6. *Microcyclus macilentus* n.sp. Syntype, G.S.C. No. 10256, x  $2\frac{1}{2}$ . Top, edge, and bottom views of a fragmentary specimen from the *Microcyclus* zone of the Lingle limestone, Grand Tower, Jackson county, Illinois. (Page 11.)
- Figures 7-9. *Microcyclus planoconvexus* n.sp. Holotype, G.S.C. No. 10257, x  $2\frac{1}{2}$ . Top, edge, and bottom views of the type specimen from the *Microcyclus* zone of the Lingle limestone, Grand Tower, Jackson county, Illinois. (Page 13.)
- Figures 10-12. *Microcyclus ventricosus* n.sp. Holotype, G.S.C. No. 10258, x  $2\frac{1}{2}$ . Top, edge, and bottom views of the type specimen from the *Microcyclus* zone of the Lingle limestone, Grand Tower, Jackson county, Illinois. (Page 15.)



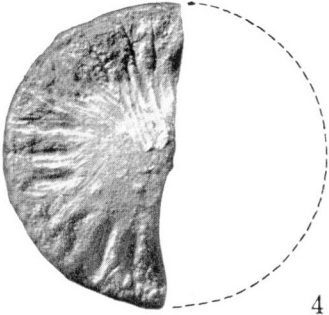
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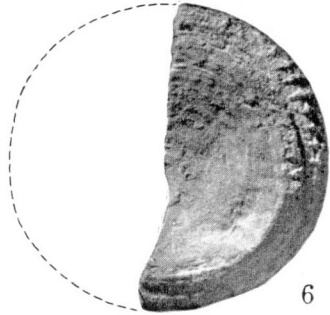
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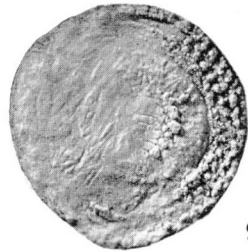
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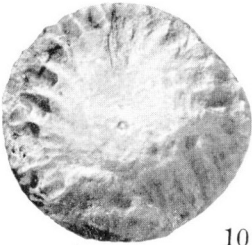
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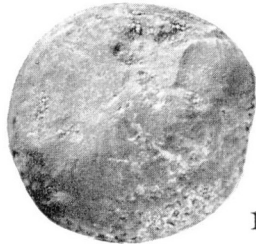
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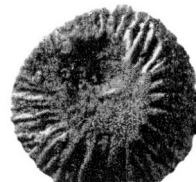
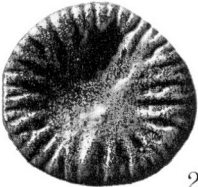
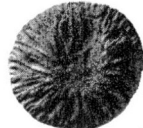
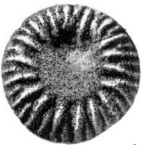
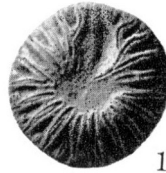
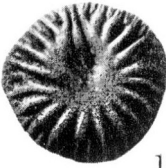
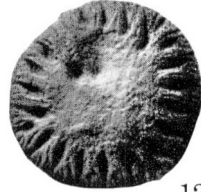
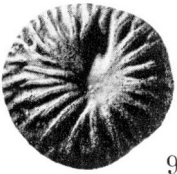
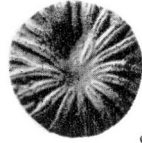
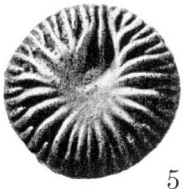
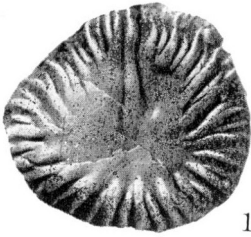
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## PLATE VII

- Figure 1. *Microcyclus southworthi* n.sp. Holotype, G.S.C. No. 10259, x 2. Top view of a specimen, selected as type, collected by Charles Southworth from the Arkona shale at the Frazer farm, 2½ miles east-by-north of Arkona, Ontario. (Page 14.)
- Figures 2, 3. *Microcyclus bifidus* Stumm. G.S.C. No. 10267, x 2. Top and bottom views of a specimen from the upper part of the Arkona shale, Tile Yard, Thedford, Ontario. (Page 7.)
- Figure 4. *Microcyclus bifidus* Stumm. G.S.C. No. 10261, x 2. Top view of a rather small specimen from the upper part of the Arkona shale, Tile Yard, Thedford, Ontario. (Page 7.)
- Figures 5-7. *Microcyclus striolatus* n.sp. Paratype, G.S.C. No. 10263, x 2. Top, edge, and bottom views of a specimen from the upper part of the Arkona shale, Tile Yard, Thedford, Ontario. (Page 15.)
- Figure 8. *Microcyclus bifidus* Stumm. G.S.C. No. 10262, x 2. Top view of a specimen from the upper part of the Arkona shale, Tile Yard, Thedford, Ontario. (Page 7.)
- Figures 9-11. *Microcyclus striolatus* n.sp. Paratype, G.S.C. No. 10264, x 2. Top, edge, and bottom views of a specimen from the upper part of the Arkona shale, Tile Yard, Thedford, Ontario. (Page 15.)
- Figure 12. *Microcyclus canadensis* n.sp. Paratype, G.S.C. No. 10266, x 2. Top view of a specimen from the upper part of the Arkona shale, Tile Yard, Thedford, Ontario. (Page 8.)
- Figures 13-15. *Microcyclus striolatus* n.sp. Paratype, G.S.C. No. 10265, x 2. Top, edge, and bottom views of a specimen from the upper part of the Arkona shale, Tile Yard, Thedford, Ontario. (Page 15.)
- Figure 16. *Microcyclus ontarioensis* n.sp. Paratype, G.S.C. No. 10267, x 2. Top view of a specimen from the upper part of the Arkona shale, Tile Yard, Thedford, Ontario. (Page 12.)
- Figures 17-19. *Microcyclus venustus* n.sp. Syntype, G.S.C. No. 10268, x 2. Top, edge, and bottom views of one of the types from the upper part of the Arkona shale, Tile Yard, Thedford, Ontario. (Page 16.)
- Figure 20. *Microcyclus ontarioensis* n.sp. G.S.C. No. 10269, x 2. Top view of a specimen from the upper part of the Arkona shale, Tile Yard, Thedford, Ontario. (Page 12.)
- Figures 21-23. *Microcyclus venustus* n.sp. Syntype, G.S.C. No. 10270, x 2. Top, edge, and bottom views of one of the types from the upper part of the Arkona shale, Tile Yard, Thedford, Ontario. (Page 16.)
- Figure 24. *Microcyclus canadensis* n.sp. G.S.C. No. 10271, x 2. Top view of a specimen from the upper part of the Arkona shale, Tile Yard, Thedford, Ontario. (Page 8.)



## PLATE VIII

- Figures 1, 2. *Microcyclus laticostatus* n.sp. Holotype, x  $2\frac{1}{2}$ . Top and bottom views of the type specimen from the calcareous lens 22 feet below the top of the Arkona shale, Tile Yard, Thedford, Ontario. (See also Pl. IV, figs. 3, 4, and 5, which illustrate the same specimen.) (Page 11.)
- Figures 3, 4. *Microcyclus canadensis* n.sp. Syntype, G.S.C. No. 10240. Top and bottom views of the syntype from the Tile Yard, Thedford, Ontario. (See also Pl. V, figs. 6, 7, and 8.) Top, x 3; bottom, x  $2\frac{1}{2}$ . (Page 8.)
- Figures 5-7. *Microcyclus microdiscus* n.sp. Paratype, G.S.C. No. 10273, x  $2\frac{1}{2}$ . Top, edge, and bottom views of a specimen from the *Microcyclus* zone of the Lingle limestone, Grand Tower, Jackson county, Illinois. (Page 11.)
- Figures 8, 9. *Microcyclus ontarioensis* n.sp. Paratype, G.S.C. Nos. 10274 and 10275, x  $2\frac{1}{2}$ . Top and bottom (attached to a crinoid stem segment) views of two different specimens from the calcareous lens 22 feet below the top of the Arkona shale, Tile Yard, Thedford, Ontario. (Page 12.)
- Figures 10, 11. *Microcyclus ontarioensis* n.sp. Paratype, x 2. Top and bottom views of a specimen from the upper part of the Arkona shale, Rock Glen, Arkona, Ontario. (Same as Pl. V, fig. 3.) (Page 12.)
- Figure 12. *Microcyclus ontarioensis* n.sp. Paratype, x 2. Top view of a specimen from the upper part of the Arkona shale, Tile Yard, Thedford, Ontario. (Same as Pl. V, fig. 19.) (Page 12.)
- Figures 13, 14. *Microcyclus ontarioensis* n.sp. G.S.C. Nos. 10276 and 10277, x  $2\frac{1}{2}$ . Top views of two specimens from the calcareous lens 22 feet below the top of the Arkona shale, Tile Yard, Thedford, Ontario. (Page 12.)
- Figure 15. *Microcyclus ontarioensis* n.sp. Paratype, x 2. Top view of a specimen from the upper part of the Arkona shale on the Stephens farm, Thedford, Ontario. (Pl. V, fig. 17, is the same specimen.) (Page 12.)
- Figure 16. *Microcyclus striolatus* n.sp. Paratype, G.S.C. No. 10278, x  $2\frac{1}{2}$ . Top view of a specimen from the calcareous lens 22 feet below the top of the Arkona shale, Tile Yard, Thedford, Ontario. (Page 15.)

