

UNIVERSITY OF KANSAS
PALEONTOLOGICAL CONTRIBUTIONS

PROTOZOA

ARTICLE 2

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FORAMINIFERA OF THE ELLIS GROUP, JURASSIC,
AT THE TYPE LOCALITY

By CECIL G. LALICKER

ARTICLE 3

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FORAMINIFERA OF THE TYPE KIOWA SHALE,
LOWER CRETACEOUS, OF KANSAS

By ALFRED R. LOEBLICH, Jr., and HELEN TAPPAN

ARTICLE 4

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STRATIGRAPHIC SIGNIFICANCE OF MISSISSIPPIAN
ENDOTHYROID FORAMINIFERA

By EDWARD J. ZELLER



UNIVERSITY OF KANSAS PUBLICATIONS

FEBRUARY 24, 1950

PRINTED BY
FERD VOILAND, JR., STATE PRINTER
TOPEKA, KANSAS
1950
22-7366

UNIVERSITY OF KANSAS
PALEONTOLOGICAL CONTRIBUTIONS

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- No. 4. PROTOZOA, Art. 1, *Studies of American fusulinids*, by M. L. Thompson; pp. 1-184, pls. 1-38, figs. 1-7; Oct. 15, 1948.

FORAMINIFERA OF THE ELLIS GROUP, JURASSIC, AT THE TYPE LOCALITY

By CECIL G. LALICKER¹

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ABSTRACT

Foraminifera are relatively rare in the Ellis group, of Jurassic age, compared with Cretaceous and Tertiary formations. They are most common in the lower part of the type section, located 7 miles southeast of Bozeman, Montana. They occur in calcareous shales interbedded with gray limestones, as shown by distribution charts. Thirty-nine species of Foraminifera are described from the type section; all are new, and most are members of the families Lagenidae and Polymorphinidae. One new genus, *Ellisina*, is described.

INTRODUCTION

Rocks called the Ellis formation, of Middle and Late Jurassic age, were first named and later described in more detail by PEALE (1893-1896). The marine rocks between formations now known as Quadrant and Morrison in the area between Three Forks and Livingston, Montana, were included in the Ellis formation. A type section of the Ellis beds was designated, measured, and described by COBBAN, IMLAY & REESIDE (1945) in the vicinity of old Fort Ellis, Montana. This type section is exposed along the north side of U. S. highway 10 on the north side of Rocky Creek Canyon, about 3.7 miles southeast of the site of Fort Ellis, or 7 miles southeast of the Court House in Bozeman, southwestern Montana, in Section 19, T. 2 S., R. 7 E., Gallatin County. The measured section is shown in figures 1 and 2.

The Ellis, originally called a formation, was raised to group rank and divided into three formations in the Sweetgrass arch area of Montana by COBBAN (1945). The formations are, in order from bottom to top, Sawtooth, Rierdon, and Swift. The lower part of the type section to the base of bed 11 is equivalent to the Sawtooth formation, the portion from the base of bed 11 through bed 17 is equivalent to the Rierdon formation, and that from the base of bed 18 to the top of the Ellis group is equivalent to the Swift formation (IMLAY, GARDNER, ROGERS & HADLEY, 1948).

The age of the Ellis group in southwestern Montana is Middle and Late Jurassic. The lower part is equivalent to the Bathonian Stage, the middle to the Callovian Stage, and the upper part is equivalent to the Oxfordian Stage (IMLAY, 1948).

The samples upon which this study is based were collected in June, 1947, at the type section of the Ellis as designated by COBBAN, IMLAY & REESIDE (1945), southeast of Bozeman, Montana. Samples were collected at one-foot vertical intervals throughout most of the section, except in the sandstones near the top. Collections were made at the contact of all shale and limestone formations. In massive limestone beds, collections were made in thin shaly zones. An uniform amount of each sample was washed in the laboratory.

Distribution of Foraminifera.—Foraminifera are relatively rare in the beds of the Ellis group compared with Cretaceous or Tertiary formations. Most of the specimens are small and poorly preserved, making it extremely difficult to find them in the washed samples.

Most of the genera and species of Foraminifera are restricted to the lower 75 feet of the Ellis group, in beds 6, 7, and 8, which are equivalent to part of the Sawtooth formation (Figures 1-4). One notable exception is bed 13 in the Rierdon formation, about 168 feet above the base of the Ellis, which contains four species which occur in lower beds. There are three species in bed 17, at the top of the

Rierdon formation, which is the uppermost bed in which Foraminifera were found. There are three species restricted to bed 7, *Ophthalmidium rotula*, n. sp., *Vaginulina barba*, n. sp., and *Paleopolymorphina gemma*, n. sp. Two species are found only in beds 6 and 7, *Vaginulina cetra*, n. sp., and *Marginulina cymba*, n. sp. There are ten species restricted to beds 7 and 8, and 13 species restricted to beds 6, 7, and 8, as shown in figure 4.

The Foraminifera of the Ellis group are most abundant in samples collected from gray, calcareous shale beds between thin gray limestones, some of which are fossiliferous, as shown in figures 1 and 2. They are more abundant in shales immediately below limestone beds than above them. Further, they are more abundant in gray, calcareous shales than in olive-green or maroon shales. Very few Foraminifera were found in silty or sandy shales, and none were found in the oölitic limestone beds or in shales adjacent to them. Foraminifera were completely absent in samples from the sandstone beds and in the interbedded shales and sandy shales of the sandstone beds. Samples numbered 17 and 25 each contained nineteen species of foraminifers, a maximum number for any sample collected from the Ellis. Each of these samples was collected from shale immediately below a limestone bed.

The Foraminifera from the Ellis group are quite characteristic of Jurassic Foraminifera in other parts of the world in that most of the genera are members of the families Lagenidae and Polymorphinidae. There are, for example, eleven species of *Marginulina*, three species of *Nodosaria*, four species of *Vaginulina*, three species of *Eoguttulina*, and three species of *Guttulina* represented in the Ellis group.

All of the species of Foraminifera found in the type section of the Ellis appear to be new. Comparisons were made with species described by SANDIDGE (1933) from the Sundance formation, as represented by topotype samples collected by the writer. Direct comparisons were made in Ottawa, Canada, with specimens described by WICKENDEN (1933) from wells in Alberta and Saskatchewan, Canada, through the courtesy of Dr. R. T. D. WICKENDEN. All of the Jurassic Foraminifera in the Cushman Laboratory for Foraminiferal Research, Sharon, Massachusetts, were examined and compared with specimens from the Ellis through the courtesy of Dr. JOSEPH A. CUSHMAN. The writer is indebted to Dr. RAYMOND C. MOORE for reading the manuscript and for many helpful suggestions, and to Mrs. MARGARET M. HUGHES for drawing the specimens.

All types and figured specimens are deposited in the Cushman Laboratory for Foraminiferal Research, Sharon, Massachusetts.

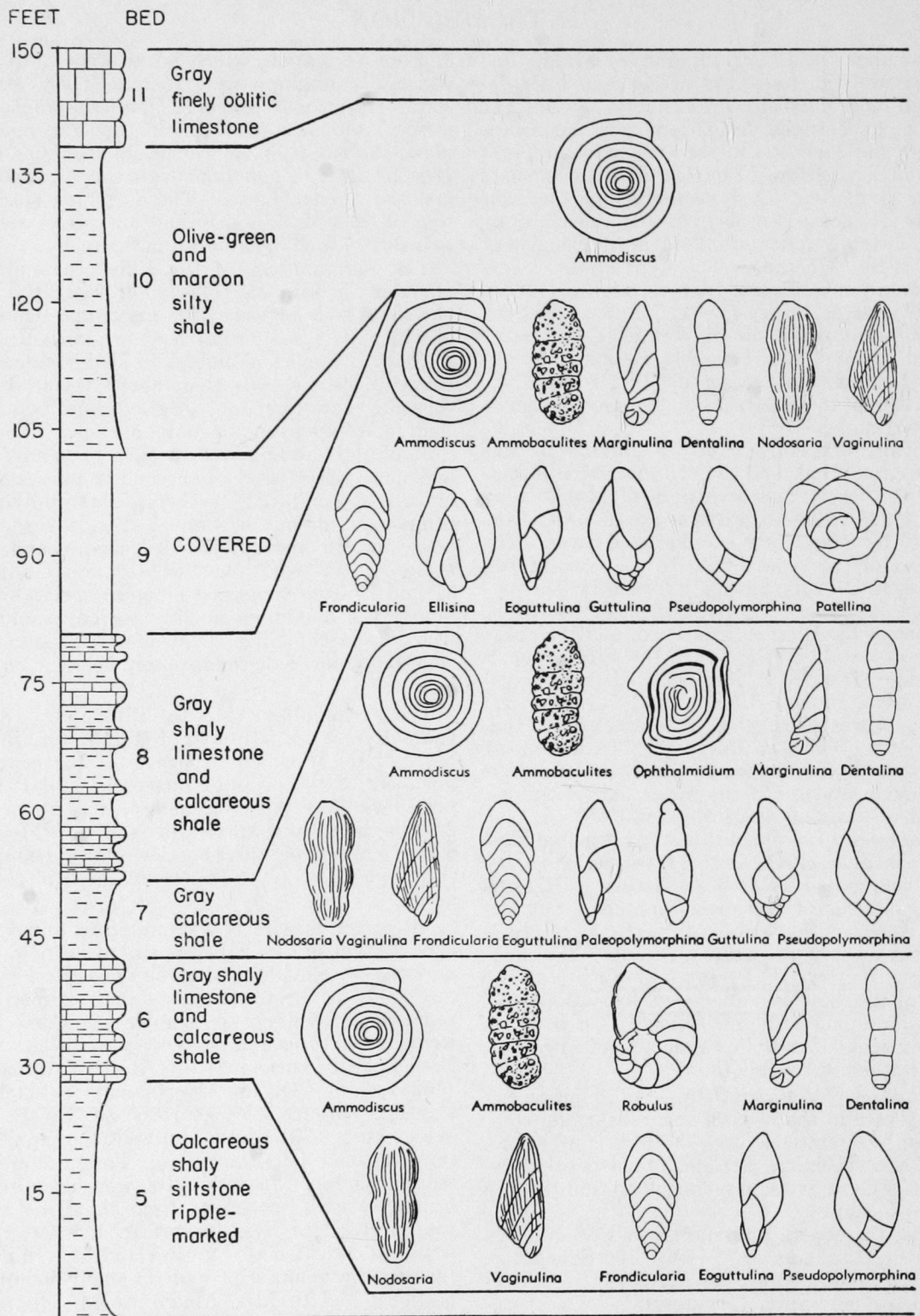


FIGURE 1.—Lower one-half of the type section of the Ellis group as measured by COBBAN, IMLAY & REESIDE (1945), showing the distribution of genera of Foraminifera in the different beds. Note the large number of Foraminifera in calcareous shale interbedded with thin gray limestone.

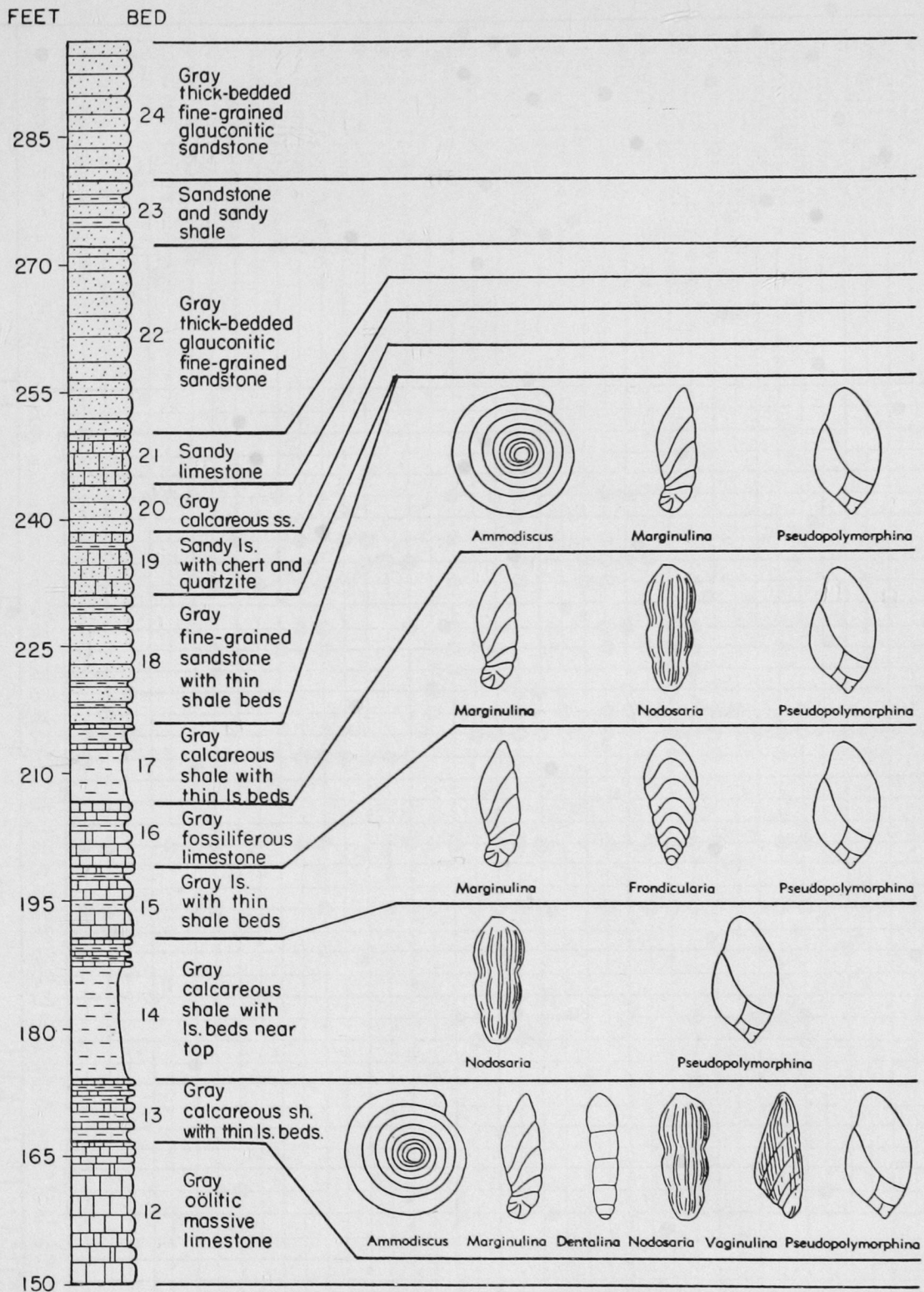


FIGURE 2.—Upper one-half of the type section of the Ellis group as measured by COBBAN, IMLAY & REESIDE (1945), showing the distribution of genera of Foraminifera in the different beds. Note the absence of Foraminifera in oölitic limestone and sandstone.

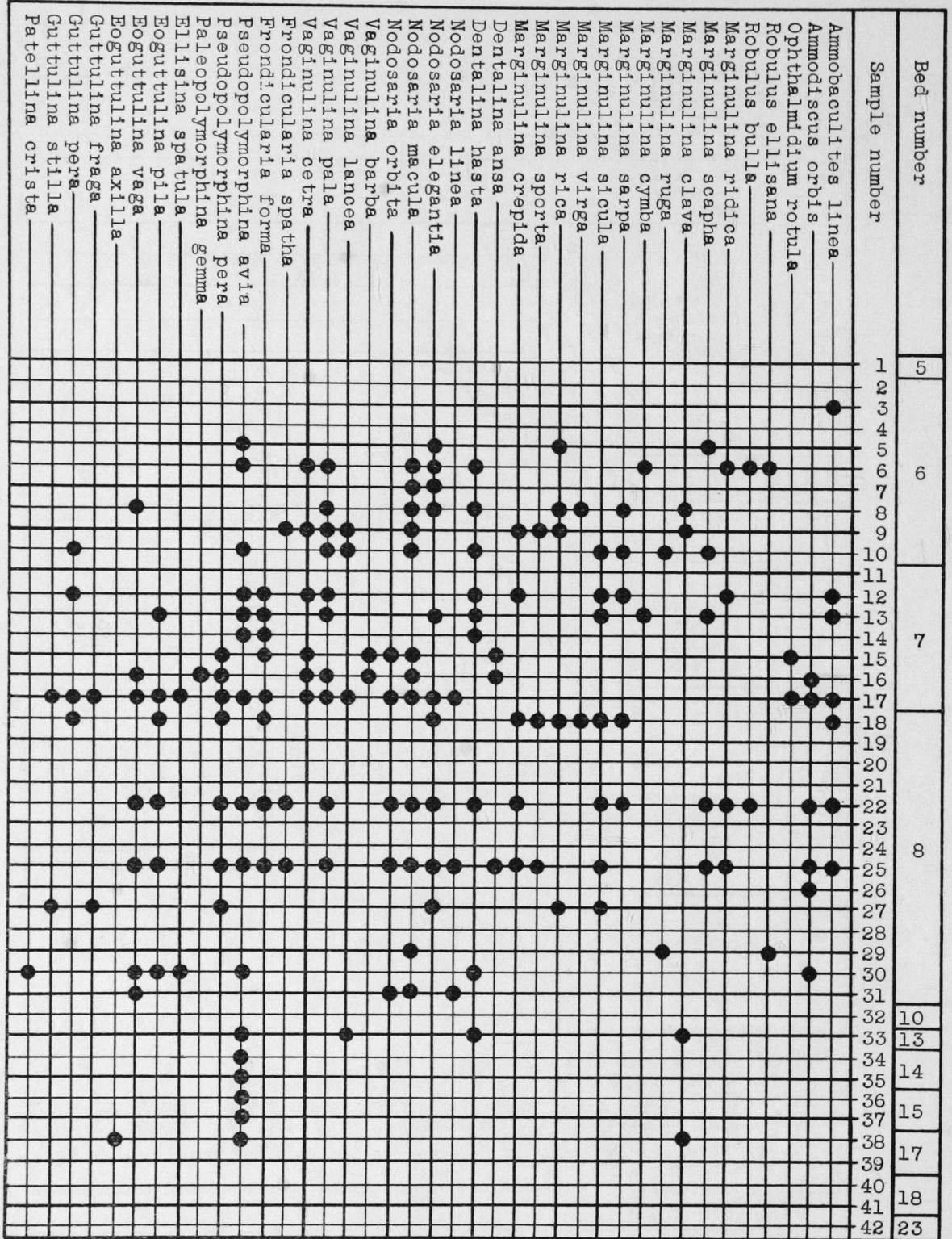


Figure 3.—Distribution chart showing distribution of Foraminifera in samples and beds of the type section of the Ellis Group.

Formation	Sawtooth				Rierdon				Swift	
	6	7	8	10	13	14	15	17	18	23
Pseudopolymorphina avia				---						
Marginulina clava		---	---	---			---			
Dentalina hasta				---						
Vaginulina lancea			---	---						
Ammobaculites linea										
Robulus ellisana		---								
Robulus bulla		---								
Marginulina ridica										
Marginulina scapha										
Marginulina ruga		---								
Marginulina sarpa										
Marginulina sicula										
Marginulina virga		---								
Marginulina rica										
Marginulina sporta										
Marginulina crepida										
Nodosaria elegantia										
Nodosaria macula										
Vaginulina pala										
Frondicularia spatha		---								
Eoguttulina vaga										
Guttulina pera										
Vaginulina cetra										
Marginulina cymba										
Ophthalmidium rotula										
Vaginulina barba										
Paleopolymorphina gemma										
Ammodiscus orbis										
Dentalina ansa										
Nodosaria linea										
Nodosaria orbita										
Frondicularia forma										
Pseudopolymorphina pera										
Ellisina spatula										
Eoguttulina pila										
Guttulina fraga										
Guttulina stilla										
Patellina crista										
Eoguttulina axilla										

FIGURE 4.—Distribution chart showing distribution of Foraminifera in different beds and formations of the type section of the Ellis group.

Samples Collected From the Type Locality of the Ellis Group, Sec. 19, T. 2 S., R. 7 E., Gallatin County, Montana

(Arranged in stratigraphic order, youngest beds at top; numbering of beds according to section by COBBAN, IMLAY & REESIDE, 1945.)

Bed No.	Sample No.
24.	24
23.	23
22.	20
21.	21
20.	19
19.	18
18.	41
18.	40
17.	39
17.	38
16.	37
15.	36
14.	35
14.	34
13.	33
12.	32
11.	31
10.	30
9.	29
8.	28
8.	27
8.	26
8.	25
8.	24
8.	23
8.	22
8.	21
8.	20
8.	19
8.	18
7.	17
7.	16
7.	15
7.	14
7.	13
7.	12
7.	11
6.	10
6.	9
6.	8
6.	7
6.	6
6.	5
6.	4
6.	3
6.	2
5.	1

DESCRIPTION OF GENERA AND SPECIES

FAMILY LITUOLIDAE

GENUS *AMMOBACULITES* CUSHMAN, 1910*Ammobaculites linea*, new species

Plate 1, figures 1a-c

Test elongate, flattened and somewhat compressed; chambers slightly inflated or depressed, narrow; sutures quite indistinct, but slightly depressed; wall arenaceous with many large quartz grains; aperture terminal, ovate, and on a short neck in most specimens. Length of holotype, 0.77 mm; maximum breadth, 0.34 mm; maximum thickness, 0.13 mm.

Remarks.—This species is similar in outline and appearance to *Ammobaculites strathearnensis* CUSHMAN & LEROY from which it differs in being more elongate and in having a smaller coiled portion.

Holotype.—Cushman Coll. No. 59705, from bed 7 of the type section of the Ellis group, southeast of Bozeman, Montana.

Occurrence.—Specimens of this species have been found in samples 3, 12, 13, 17, 18, 22, and 25, which were collected from beds 6, 7, and 8 of the type section of the Ellis group.

FAMILY AMMODISCIDAE

GENUS *AMMODISCUS* REUSS, 1861*Ammodiscus orbis*, new species

Plate 1, figure 2

Test flattened and round, somewhat concave in the early portion; chamber a long undivided coil increasing gradually in size; suture depressed and very distinct; wall smooth, consisting of very fine quartz grains and ferruginous cement; aperture rounded, at the end of the tubular chamber. Maximum breadth of holotype, 0.38 mm.

Remarks.—This species is somewhat similar to *Ammodiscus rosanovi* ZALESSKY, from the Jurassic of the U. S. S. R., from which it differs in having a more rounded second chamber and in having fewer whorls.

Holotype.—Cushman Coll. No. 59707, from bed 8 of the type section of the Ellis group, southeast of Bozeman, Montana.

Occurrence.—Specimens of this species have been found in samples 16, 17, 22, 25, 26, and 30, which were collected from beds 7 and 8 of the type section of the Ellis.

FAMILY OPHTHALMIDIIDAE

GENUS *OPHTHALMIDIUM* ZWINGLI &

KÜBLER, 1870

Ophthalmidium rotula, new species

Plate 1, figures 3a, b

Test ovate to subquadrate in outline, compressed, early portion depressed; chambers tubular, in the early portion several whorls in length, in the adult portion generally two to a whorl; sutures distinct, depressed; wall calcareous and smooth. Maximum breadth of holotype, 0.47.

Remarks.—This species is similar to *Ophthalmidium orbiculare* BURBACH, from the Jurassic of Germany, from which it differs in being less rounded in outline and in having more whorls, especially in the early portion.

Holotype.—Cushman Coll. No. 59708, from bed 7 of the type section of the Ellis group, southeast of Bozeman, Montana.

Occurrence.—Specimens of this interesting species were found in samples 15 and 17, both of which were collected from bed 7 of the type section of the Ellis.

FAMILY LAGENIDAE

GENUS *ROBULUS* MONTFORT, 1808*Robulus ellisana*, new species

Plate 1, figures 4a, b

Test subovate in outline, thick; chambers relatively narrow and long, slightly inflated; sutures distinct, slightly curved backward, somewhat depressed, relatively wide; wall calcareous, smooth; aperture distinct and upon a peripheral extension. Maximum breadth of holotype, 0.88 mm; thickness, 0.33 mm.

Remarks.—This species resembles *Robulus malonianus* ALBRITTON, from the Upper Jurassic rocks of the Malone Mountains of Texas, from which it differs in having longer chambers, a larger umbilical area, and sutures which are less curved.

Holotype.—Cushman Coll. No. 59710, from bed 6 of the type section of the Ellis group, southeast of Bozeman, Montana.

Occurrence.—This species was found in samples 6 and 29, which were collected in beds 6 and 8 of the type section of the Ellis group.

Robulus bulla, new species

Plate 1, figures 5a, b

Test small, round, and thick with large central bosses; chambers narrow and slightly inflated; sutures curved backward, depressed; wall smooth, calcareous; aperture small, indistinct, at the peripheral margin. Maximum breadth of holotype, 0.63 mm; thickness, 0.33 mm.

Remarks.—This species is similar in outline to *Robulina oolithica* TERQUEM, Jurassic of France, from which it differs in having higher chambers, a larger central boss, and more highly curved sutures.

Holotype.—Cushman Coll. No. 59711, from bed 8 of the type section of the Ellis group southeast of Bozeman, Montana.

Occurrence.—This small species was found in two samples, 6 and 22, which were collected from beds 6 and 8 of the type section of the Ellis group.

GENUS **MARGINULINA** D'ORBIGNY, 1826

Marginulina ridica, new species

Plate 1, figures 6a-c

Test elongate, slender, early portion tightly coiled, sides of uniserial portion nearly parallel, subovate in end view; chambers short, inflated; sutures straight, at angles of 67° with sides of test,

depressed; wall calcareous, slightly rough; aperture terminal, near peripheral margin and slightly elevated. Length of holotype, 0.93 mm; breadth of uniserial portion, 0.25 mm; thickness, 0.16 mm.

Remarks.—This species is similar to *Marginulina consobrina* TERQUEM, Jurassic of France, from which it differs in being a thicker form, and also somewhat wider in the uniserial portion.

Holotype.—Cushman Coll. No. 59712, from bed 8 of the type section of the Ellis group southeast of Bozeman, Montana.

Occurrence.—This species was found in samples 6, 12, 22, and 25, which were collected from beds 6, 7, and 8 of the type section of the Ellis group.

Marginulina scapha, new species

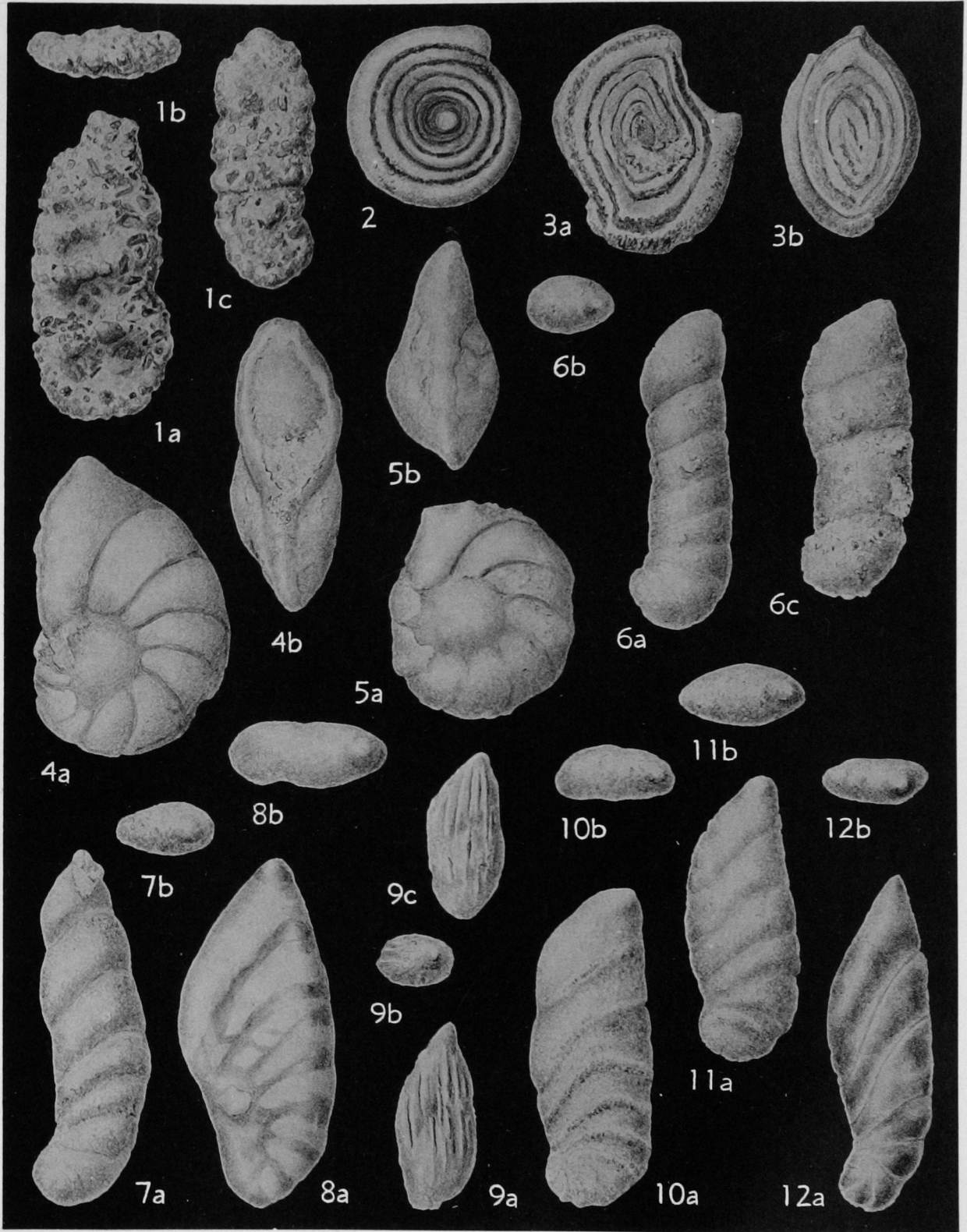
Plate 1, figures 7a, b

Test elongate, early portion close-coiled, uniserial portion somewhat curved, flattened; chambers short in early portion, much higher in adult portion of test, slightly inflated; sutures depressed, curved upward; wall calcareous, smooth; aperture terminal, near peripheral margin and upon a short neck. Length of holotype, 1.03 mm; breadth of uniserial portion, 0.20 mm; thickness, 0.16 mm.

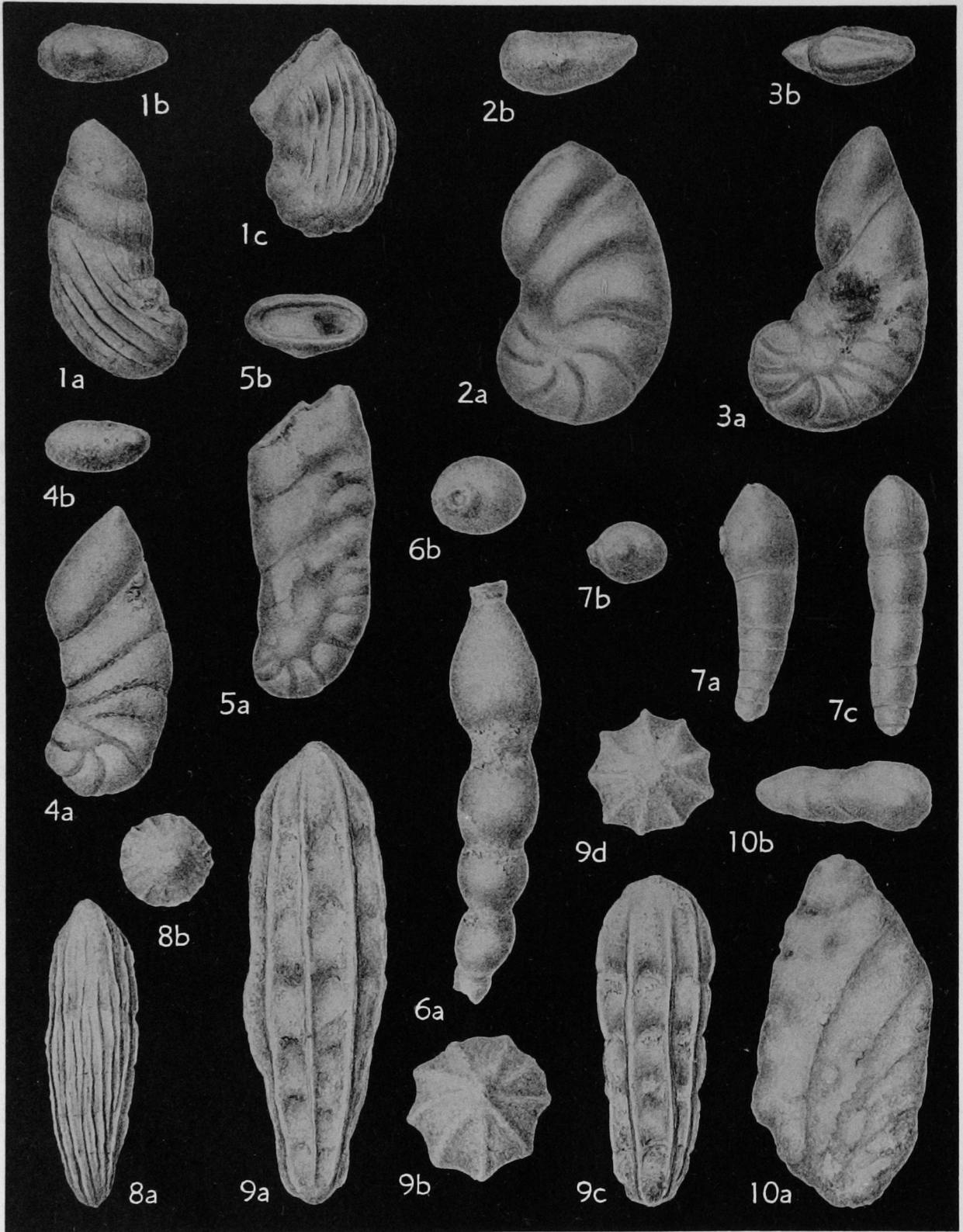
Remarks.—This species is similar in outline to *Marginulina ambigua* SCHWAGER, Jurassic, Ger-

EXPLANATION OF PLATE 1

FIGURE	PAGE	FIGURE	PAGE
1a-c— <i>Ammobaculites linea</i> , n. sp.....	11	view, × 60. From Bed 8, Ellis group, Boze-	
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1a, side view, 1b, apertural view, × 70. 1c,			
Paratype, Cushman Coll. No. 59706, side		7a, b— <i>Marginulina scapha</i> , n. sp.....	12
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man, Montana.		view, 7b, apertural view, × 60. From Bed 8,	
		Ellis group, Bozeman, Montana.	
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view, × 85. From Bed 8, Ellis group, Boze-		view, 8b, apertural view, × 60. From Bed	
man, Montana.		13, Ellis group, Bozeman, Montana.	
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3a, Holotype, Cushman Coll. No. 59708, side		9a, b, Holotype, Cushman Coll. No. 59716,	
view, × 85. 3b, Paratype, Cushman Coll.		9a, side view, 9b, apertural view, × 60. 9c,	
No. 59709, side view, × 85. From Bed 7,		Paratype, Cushman Coll. No. 59717, side	
Ellis group, Bozeman, Montana.		view, × 60. From Bed 6, Ellis group, Boze-	
4a, b— <i>Robulus ellisana</i> , n. sp.....	11	man, Montana.	
Holotype, Cushman Coll. No. 59710, 4a, side		10a, b— <i>Marginulina cymba</i> , n. sp.....	13
view, 4b, apertural view, × 60. From Bed 6,		Holotype, Cushman Coll. No. 59718, 10a,	
Ellis group, Bozeman, Montana.		side view, 10b, apertural view, × 60. From	
5a, b— <i>Robulus bulla</i> , n. sp.....	12	Bed 6, Ellis group, Bozeman, Montana.	
Holotype, Cushman Coll. No. 59711, 5a, side		11a, b— <i>Marginulina sarpa</i> , n. sp.....	14
view, 5b, apertural view, × 60. From Bed		Holotype, Cushman Coll. No. 59719, 11a,	
8, Ellis group, Bozeman, Montana.		side view, 11b, apertural view, × 60. From	
6a-c— <i>Marginulina ridica</i> , n. sp.....	12	Bed 8, Ellis group, Bozeman, Montana.	
6a, b, Holotype, Cushman Coll. No. 59712,		12a, b— <i>Marginulina sicula</i> , n. sp.....	14
6a, side view, 6b, apertural view, × 60. 6c,		Holotype, Cushman Coll. No. 59720, 12a,	
Paratype, Cushman Coll. No. 59713, side		side view, 12b, apertural view, × 60. From	
		Bed 8, Ellis group, Bozeman, Montana.	



LALICKER—Jurassic Foraminifera



LALICKER—Jurassic Foraminifera

many, from which it differs in having curved sutures and a wider uniserial portion.

Holotype.—Cushman Coll. No. 59714, from bed 8 of the type section of the Ellis group southeast of Bozeman, Montana.

Occurrence.—This distinctive species was found in samples 5, 10, 13, 22, and 25, which were collected from beds 6, 7, and 8 of the type section of the Ellis group.

Marginulina clava, new species

Plate 1, figures 8a, b

Test broad and elongate, increasing in width gradually, flattened; chambers short and narrow; sutures distinct, appearing as broad bands; wall calcareous, smooth; aperture on peripheral margin, somewhat elevated. Length of holotype, 1.02 mm; maximum breadth, 0.45 mm; thickness, 0.20 mm.

Remarks.—The outline of this species is somewhat similar to *Marginulina trigona* TERQUEM, from the Jurassic of France, but it differs in being more compressed and in having a larger coiled portion.

Holotype.—Cushman Coll. No. 59715, from bed 13 of the type section of the Ellis group southeast of Bozeman, Montana.

Occurrence.—This large species was noted in samples 8, 9, 33, and 38, which were collected from beds 6, 13, and 17 of the type section of the Ellis group.

Marginulina ruga, new species

Plate 1, figures 9a-c

Test small, short, and relatively wide, prominent costae which are parallel to sides of test and best developed in the uniserial portion, terminal end somewhat pointed, early coiled portion indistinct;

chambers indistinct, high, and slightly inflated; sutures straight, depressed, quite indistinct; wall calcareous, rough; aperture at peripheral margin, elevated. Length of holotype, 0.55 mm; breadth, 0.26 mm; thickness, 0.15 mm.

Remarks.—This small species is somewhat like *Marginulina radiata* TERQUEM, from the Jurassic of France, from which it differs in having parallel sides throughout and in having finer costae.

Holotype.—Cushman Coll. No. 59716, from bed 6 of the type locality of the Ellis group southeast of Bozeman, Montana.

Occurrence.—This distinctive species was present in samples 10 and 29, which were collected from beds 6 and 8 of the type locality and section of the Ellis group.

Marginulina cymba, new species

Plate 1, figures 10a, b

Test robust, elongate, rather broad, with sides of uniserial portion nearly parallel; chambers short, somewhat depressed; sutures curved, becoming straight in the adult portion, limbate; wall calcareous, somewhat rough; aperture terminal, small, at peripheral margin. Length of holotype, 0.92 mm; breadth of uniserial portion, 0.35 mm; thickness, 0.16 mm.

Remarks.—This robust species is similar in shape to *Marginulina beierana* GÜMBEL, from the Jurassic of Germany, from which it differs in having a wider uniserial portion and in having curved sutures.

Holotype.—Cushman Coll. No. 59718, from bed 6 of the type section of the Ellis group southeast of Bozeman, Montana.

Occurrence.—This species has been found in

EXPLANATION OF PLATE 2

FIGURE	PAGE	FIGURE	PAGE
1a-c— <i>Marginulina virga</i> , n. sp.....	14	view, 6b, apertural view, × 70. From Bed 8, Ellis group, Bozeman, Montana.	
1a, b, Holotype, Cushman Coll. No. 59721.			
1a, side view, 1b, apertural view, × 60. 1c, Paratype, Cushman Coll. No. 59722, side view, × 60. From Bed 8, Ellis group, Bozeman, Montana.		7a-c— <i>Dentalina hasta</i> , n. sp.....	15
2a, b— <i>Marginulina rica</i> , n. sp.....	14	7a, b, Holotype, Cushman Coll. No. 59728, 7a, side view, 7b, apertural view, × 70. 7c, Paratype, Cushman Coll. No. 59729, side view, × 70. From Bed 7, Ellis group, Bozeman, Montana.	
Holotype, Cushman Coll. No. 59723, 2a, side view, 2b, apertural view, × 60. From Bed 6, Ellis group, Bozeman, Montana.		8a, b— <i>Nodosaria linea</i> , n. sp.....	15
3a, b— <i>Marginulina sporta</i> , n. sp.....	14	Holotype, Cushman Coll. No. 59730, 8a, side view, 8b, apertural view, × 100. From Bed 7, Ellis group, Bozeman, Montana.	
Holotype, Cushman Coll. No. 59724, 3a, side view, 3b, apertural view, × 60. From Bed 6, Ellis group, Bozeman, Montana.		9a-d— <i>Nodosaria elegantia</i> , n. sp.....	15
4, 5— <i>Marginulina crepida</i> , n. sp.....	14	9a, b, Holotype, Cushman Coll. No. 59731, 9a, side view, 9b, apertural view, × 100. 9c, d, Paratype, Cushman Coll. No. 59732, 9c, side view, 9d, apertural view, × 100. From Bed 8, Ellis group, Bozeman, Montana.	
4a, b, Holotype, Cushman Coll. No. 59725, 4a, side view, 4b, apertural view, × 60. 5a, b, Paratype, Cushman Coll. No. 59726, 5a, side view, 5b, apertural view, × 60. From Bed 8, Ellis group, Bozeman, Montana.		10a, b— <i>Vaginulina barba</i> , n. sp.....	16
6a, b— <i>Dentalina ansa</i> , n. sp.....	15	Holotype, Cushman Coll. No. 59737, 10a, side view, 10b, apertural view, × 60. From Bed 7, Ellis group, Bozeman, Montana.	
Holotype, Cushman Coll. No. 59727, 6a, side			

samples 6 and 13, which were collected from beds 6 and 7 of the type section of the Ellis group.

Marginulina sarpa, new species

Plate 1, figures 11a, b

Test elongate, somewhat pointed, early portion close-coiled, later uniserial portion straight; chambers short, narrow, slightly inflated; sutures distinct, depressed and gently curved throughout; wall calcareous, smooth; aperture terminal, at peripheral margin, elevated. Length of holotype, 0.83 mm; breadth, 0.33 mm; thickness, 0.20 mm.

Remarks.—*Marginulina contracta* TERQUEM from the Bathonian of Varsovie, Poland, is similar in outline to this species, but Terquem's species is more rounded than this one.

Holotype.—Cushman Coll. No. 59719, from bed 8 of the type section of the Ellis group southeast of Bozeman, Montana.

Occurrence.—This species has been noted in samples 8, 10, 12, 18, and 22, which were collected from beds 6, 7, and 8 of the type section of the Ellis group.

Marginulina sicula, new species

Plate 1, figures 12a, b

Test elongate, early portion small, increasing in width to last chamber, somewhat pointed, flattened; chambers low and inflated; sutures distinct, depressed and gently curved upward; wall calcareous, smooth; aperture terminal, at peripheral margin, small and slightly elevated. Length of holotype, 0.98 mm; maximum breadth, 0.30 mm; thickness, 0.13 mm.

Remarks.—This elongate species resembles *Marginulina ambigua* SCHWAGER, from the Jurassic of Germany, from which it differs in being somewhat wider and in having longer chambers.

Holotype.—Cushman Coll. No. 59720, from bed 8 of the type section of the Ellis group southeast of Bozeman, Montana.

Occurrence.—This distinctive species has been found in samples 10, 12, 13, 18, 22, 25, and 27, which were collected from beds 6, 7, and 8 of the type section of the Ellis group.

Marginulina virga, new species

Plate 2, figures 1a-c

Test broad, short, flattened and somewhat pointed, prominent costae parallel to sides of test in early portion of test but absent on last chambers; chambers low, inflated, indistinct in early portion; sutures faint in early portion, distinct and depressed in later portion, straight; wall calcareous, smooth; aperture near peripheral margin, rounded. Length of holotype, 0.77 mm; maximum breadth, 0.30 mm; thickness, 0.17 mm.

Remarks.—This species is similar to *Marginulina*

metensis TERQUEM, from the Jurassic of France, from which it differs in having a much broader early portion and a more pointed adult portion.

Holotype.—Cushman Coll. No. 59721, from bed 8 of the type section of the Ellis group southeast of Bozeman, Montana.

Occurrence.—This interesting species was noted in samples 8 and 18, which were collected from beds 6 and 8 of the type section of the Ellis group.

Marginulina rica, new species

Plate 2, figures 2a, b

Test short and broad, compressed, early coiled portion making up a large portion of the test; chambers relatively high, somewhat inflated in the adult portion of the test; sutures broad, depressed; wall calcareous, smooth; aperture terminal at peripheral margin and small. Length of holotype, 0.83 mm; breadth, 0.47 mm; thickness, 0.18 mm.

Remarks.—This species resembles *Cristellaria limata* SCHWAGER, from the Jurassic of Germany, from which it differs in having depressed sutures and a broader coiled portion.

Holotype.—Cushman Coll. No. 59723, from bed 6 of the type section of the Ellis group southeast of Bozeman, Montana.

Occurrence.—This large species has been found in samples 5, 8, 9, 18, and 27, which were collected from beds 6 and 8 of the type section of the Ellis group.

Marginulina sporta, new species

Plate 2, figures 3a, b

Test rounded except in uncoiled adult portion, pointed and compressed, early loosely coiled portion making up a large portion of the test; chambers in early portion low, in adult uniserial portion high; sutures distinct, wide, and depressed, gently curved upward; wall calcareous, smooth; aperture terminal, on peripheral margin. Length of holotype, 0.90 mm; breadth of early portion, 0.48 mm; thickness, 0.16 mm.

Remarks.—This species is somewhat similar in outline to *Cristellaria candonensis* D'ORBIGNY, from which it differs in higher chambers in the uniserial portion and in being more slender.

Holotype.—Cushman Coll. No. 59724, from bed 6 of the type section of the Ellis group southeast of Bozeman, Montana.

Occurrence.—This species was found in samples 9, 18, and 25, which were collected from beds 6 and 8 of the type section of the Ellis group.

Marginulina crepida, new species

Plate 2, figures 4a, b, 5a, b

Test robust, elongate, broad, the early coiled portion large, uniserial portion curved in most specimens; chambers low in early portion, medium in

height in uniserial portion, end of last chamber somewhat truncated; sutures distinct, wide, and slightly curved upward in early portion and downward in uniserial portion; wall calcareous, smooth; aperture terminal, at peripheral margin and somewhat elevated. Length of holotype, 0.85 mm; breadth of uniserial portion, 0.32 mm; thickness, 0.15 mm.

Remarks.—This species differs from *Marginulina jurassica* GÜMBEL, from the Jurassic of Germany, in having a broader coiled portion and curved sutures in the uniserial portion.

Holotype.—Cushman Coll. No. 59725 from bed 8 of the type section of the Ellis group southeast of Bozeman, Montana.

Occurrence.—This common species was found in samples 9, 12, 18, 22, and 25, which were collected from beds 6, 7, and 8 of the type section of the Ellis group.

GENUS *DENTALINA* D'ORBIGNY, 1826

Dentalina ansa, new species

Plate 2, figures 6a, b

Test elongate, curved, rounded in section; chambers high and inflated, becoming increasingly higher toward the adult portion; sutures depressed, somewhat indistinct; wall calcareous, smooth; aperture terminal and radiate. Length of holotype, 1.23 mm; maximum breadth, 0.27 mm; thickness, 0.23 mm.

Remarks.—This species differs from *Dentalina jurensis* TERQUEM, from the Jurassic of France, in being less curved, in having higher chambers, and in being more constricted at the sutures.

Holotype.—Cushman Coll. No. 59727, from bed 8 of the type section of the Ellis group southeast of Bozeman, Montana.

Occurrence.—This species was found in samples 15, 16, and 25, which were collected from beds 7 and 8 of the type section of the Ellis group.

Dentalina hasta, new species

Plate 2, figures 7a-c

Test small, curved, gradually increasing in thickness toward the adult portion; chambers low in early portion but higher in most of test, inflated; sutures distinct, depressed; wall calcareous, smooth; aperture terminal, radiate. Length of holotype, 0.60 mm; maximum breadth, 0.20 mm; thickness, 0.20 mm.

Remarks.—This species is similar to *Dentalina chrysalis* KÜBLER & ZWINGLI, Jurassic of Germany, from which it differs in having a more rounded early portion and shorter chambers.

Holotype.—Cushman Coll. No. 59728, from bed 7 of the type section of the Ellis group southeast of Bozeman, Montana.

Occurrence.—This common species was noted in samples 6, 8, 10, 12, 13, 14, 22, 30, and 33, which were collected from beds 6, 7, 8, and 13 of the type section of the Ellis group.

GENUS *NODOSARIA* LAMARCK, 1812

Nodosaria linea, new species

Plate 2, figures 8a, b

Test small, straight, rounded in section and relatively broad, initial end rounded, about nine relatively fine costae parallel to sides of test and some discontinuous; chambers of medium height, increasing gradually in size toward the adult portion; sutures indistinct but generally visible; wall calcareous, smooth; aperture terminal, radiate. Length of holotype, 0.54 mm; maximum breadth, 0.15 mm; thickness, 0.15 mm.

Remarks.—This species differs from *Nodosaria opalini* BARTENSTEIN, Jurassic of Germany, in having higher chambers and finer costae.

Holotype.—Cushman Coll. No. 59730, from bed 7 of the type section of the Ellis group southeast of Bozeman, Montana.

Occurrence.—This distinctive species has been found in samples 17, 25, and 31, which were collected from beds 7 and 8 of the type section of the Ellis group.

Nodosaria elegatia, new species

Plate 2, figures 9a-d

Test straight, thick, initial end rounded, about three coarse costae parallel to the sides of the test visible; chambers low with lower portions concave; wall calcareous, smooth; aperture terminal, central in position, radiate. Length of holotype, 0.81 mm; maximum breadth, 0.25 mm; thickness, 0.25 mm.

Remarks.—This species has the appearance of a *Siphogenerina*, but several cross sections made of the early portion revealed that it is uniserial throughout. It is somewhat similar to *Nodosaria simoniana* D'ORBIGNY, from the Jurassic of France, but differs in having continuous coarse costae and chambers which are depressed at the lower margin.

Holotype.—Cushman Coll. No. 59731 from bed 8 of the type section of the Ellis group southeast of Bozeman, Montana.

Occurrence.—This common and very distinctive species was found in samples 5, 6, 7, 8, 13, 17, 18, 22, 25, and 27, which were collected from beds 6, 7, and 8 of the type section of the Ellis group.

Nodosaria macula, new species

Plate 3, figures 1a-d

Test elongate, rounded, sides nearly parallel with about six distinctive costae parallel to sides visible, apertural end somewhat pointed; chambers indis-

tinct, slightly inflated; sutures indistinct, depressed in adult portion; wall calcareous, rough; aperture terminal, central in position, and radiate. Length of holotype, 0.88 mm; maximum breadth, 0.23 mm; maximum thickness, 0.28 mm.

Remarks.—This species is similar to *Nodosaria corallina* GÜMBEL, from the Jurassic of Germany, from which it differs in being less slender and having more costae.

Holotype.—Cushman Coll. No. 59733, from bed 8 of the type section of the Ellis group southeast of Bozeman, Montana.

Occurrence.—This common species was found in samples 6, 7, 8, 9, 10, 15, 16, 17, 22, 25, 29, and 31, which were collected from beds 6, 7, and 8 of the type section of the Ellis group.

Nodosaria orbita, new species

Plate 3, figures 2a-d

Test elongate, rounded, sides nearly parallel, with five costae parallel to sides visible; chambers high, inflated, and about the same length throughout the test; sutures depressed; wall calcareous, rough; aperture terminal, central in position and rounded. Length of holotype, 0.65 mm; breadth, 0.16 mm; thickness, 0.16 mm.

Remarks.—This species resembles *Nodosaria dispar* FRANKE, Jurassic of Germany, from which it differs in having a smaller early portion and fewer costae.

Holotype.—Cushman Coll. No. 59735, from bed 8 of the type section of the Ellis group southeast of Bozeman, Montana.

Occurrence.—This species was found in samples 15, 17, 22, 25, and 31, which were collected from beds 7 and 8 of the type section of the Ellis group.

GENUS *VAGINULINA* D'ORBIGNY, 1826

Vaginulina barba, new species

Plate 2, figures 10a, b

Test broad, compressed, somewhat subquadrate in outline, early portion indistinct; chambers increasing gradually in height, only slightly inflated; sutures distinct, depressed, gently curved upward; wall calcareous, smooth; aperture terminal, at peripheral margin. Length of holotype, 1.03 mm; maximum breadth, 0.50 mm; thickness, 0.20 mm.

Remarks.—This species resembles *Cristellaria foliacea* SCHWAGER, from the Jurassic of Germany, but differs in having higher and longer chambers.

Holotype.—Cushman Coll. No. 59737, from bed 7 of the type section of the Ellis group southeast of Bozeman, Montana.

Occurrence.—This species was noted in samples 15 and 16, both of which were collected from bed 7 of the type section of the Ellis group.

Vaginulina lancea, new species

Plate 3, figure 3

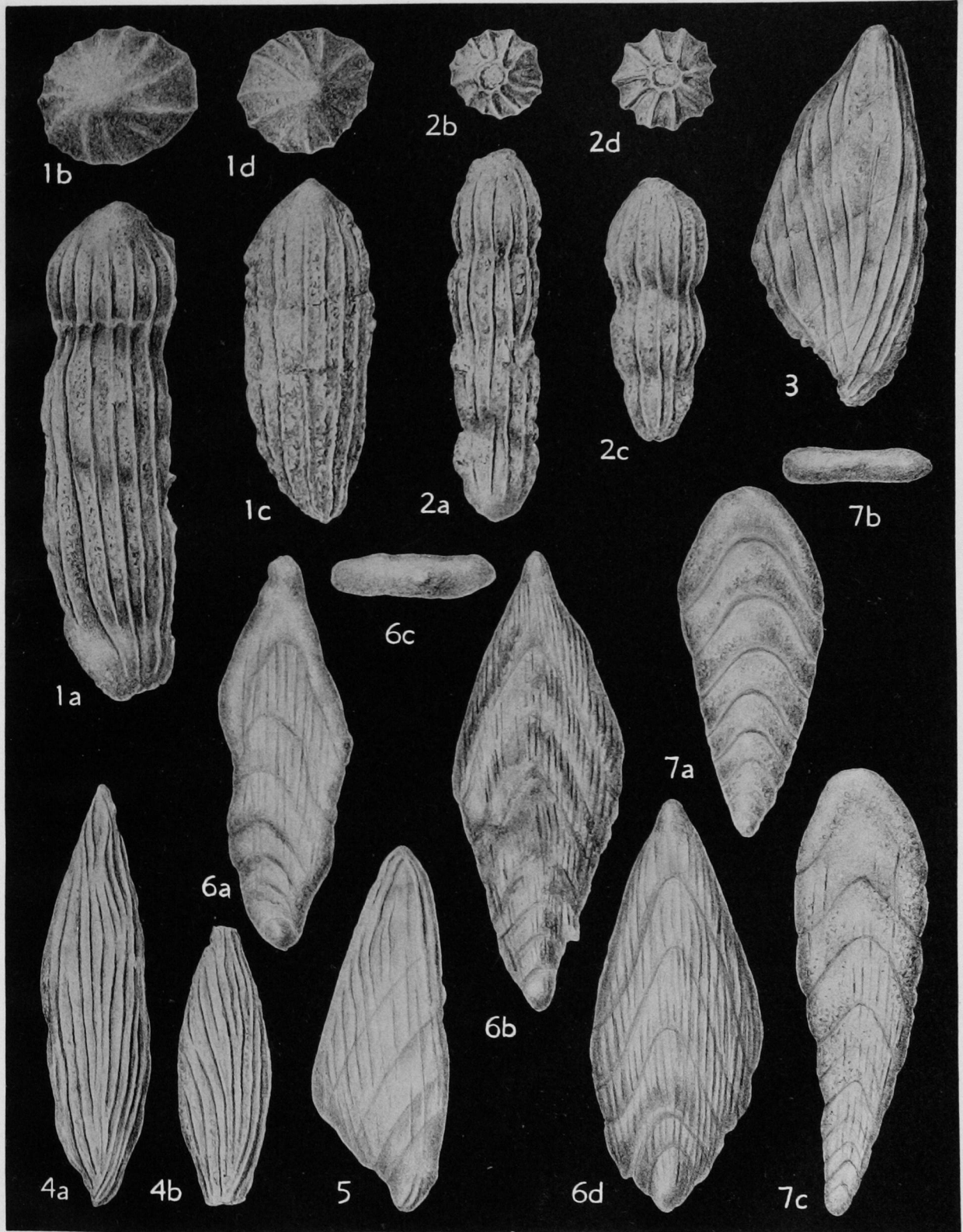
Test broad, subrhomboidal in outline, compressed, with several costae roughly parallel to the sides of the test which come together in the central portion; chambers flat, low, increasing gradually in height as added; sutures distinct, gently curved upward; wall calcareous, smooth; aperture terminal, large, at peripheral margin. Length of holotype, 1.10 mm; maximum breadth, 0.50 mm.

Remarks.—This species differs from *Vaginulina striata* D'ORBIGNY, from the Jurassic of France, in having coarser costae which coalesce in the middle portion of the test.

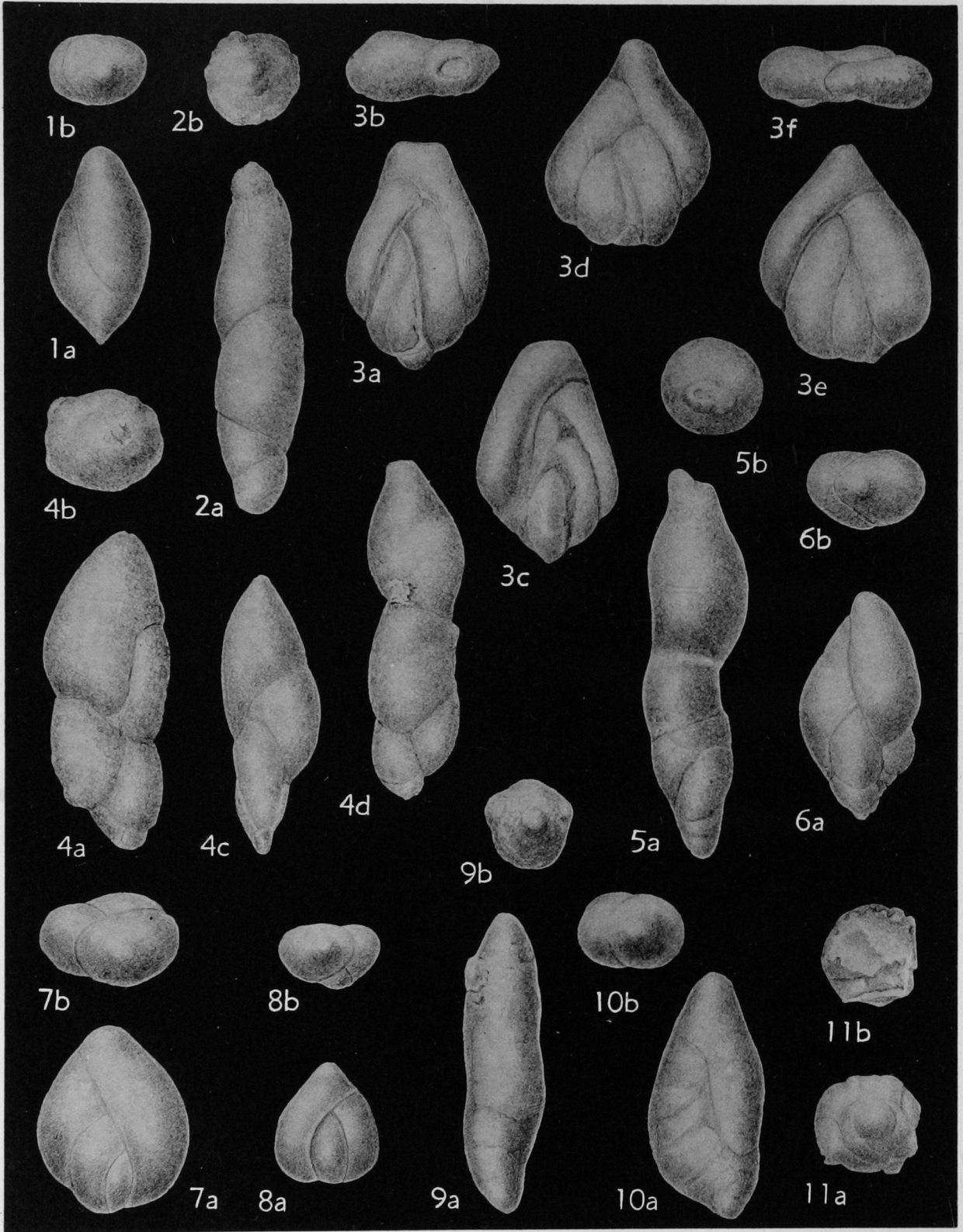
Holotype.—Cushman Coll. No. 59738, from bed 7 of the type section of the Ellis group southeast of Bozeman, Montana.

EXPLANATION OF PLATE 3

FIGURE	PAGE	FIGURE	PAGE
1a-d— <i>Nodosaria macula</i> , n. sp.....	15	No. 59740, side view, × 60. From Bed 7, Ellis group, Bozeman, Montana.	
1a, b, Holotype, Cushman Coll. No. 59733,			
1a, side view, 1b, apertural view, × 100.			
1c, d, Paratype, Cushman Coll. No. 59734,		5— <i>Vaginulina cetra</i> , n. sp.....	17
1c, side view, 1d, apertural view, × 100.		Holotype, Cushman Coll. No. 59741, side	
From Bed 8, Ellis group, Bozeman, Mon-		view, × 60. From Bed 7, Ellis group, Boze-	
tana.		man, Montana.	
2a-d— <i>Nodosaria orbita</i> , n. sp.....	16	6a-d— <i>Frondicularia spatha</i> , n. sp.....	17
2a, b, Holotype, Cushman Coll. No. 59735,		6a, Paratype, Cushman Coll. No. 59742, side	
2a, side view, 2b, apertural view, × 100.		view of microspheric form, × 60. 6b, c,	
2c, d, Paratype, Cushman Coll. No. 59736,		Holotype, Cushman Coll. No. 59743, 6b, side	
2c, side view, 2d, apertural view, × 100.		view, 6c, apertural view, × 60. 6d, Para-	
From Bed 8, Ellis group, Bozeman, Mon-		type, Cushman Coll. No. 59744, side view,	
tana.		× 60. From Bed 8, Ellis group, Bozeman,	
3— <i>Vaginulina lancea</i> , n. sp.....	16	Montana.	
Holotype, Cushman Coll. No. 59738, side		7a-c— <i>Frondicularia forma</i> , n. sp.....	18
view, × 60. From Bed 7, Ellis group, Boze-		7a, b, Holotype, Cushman Coll. No. 59745,	
man, Montana.		7a, side view, 7b, apertural view, × 60. 7c,	
4a, b— <i>Vaginulina pala</i> , n. sp.....	17	Paratype, Cushman Coll. No. 59746, side	
4a, Holotype, Cushman Coll. No. 59739, side		view, × 60. From Bed 8, Ellis group, Boze-	
view, × 60. 4b, Paratype, Cushman Coll.		man, Montana.	



LALICKER—Jurassic Foraminifera



LALICKER—Jurassic Foraminifera

Vaginulina pala, new species

Plate 3, figures 4a, b

Test elongate, slender, pointed at both ends, but more so at the apertural end, thin, compressed, with several costae parallel to sides of test which coalesce in the center; chambers indistinct but flattened; sutures indistinct; wall calcareous, smooth; aperture terminal at peripheral margin. Length of holotype, 1.24 mm; maximum breadth, 0.32 mm.

Remarks.—This species is somewhat like *Mariginulina biangulata* TERQUEM, from the Jurassic of France, from which it differs in being more slender and in having coarser costae.

Holotype.—Cushman Coll. No. 59739, from bed 7 of the type section of the Ellis group southeast of Bozeman, Montana.

Occurrence.—This very common species was found in samples 6, 8, 9, 10, 12, 13, 16, 17, 22, and 25, which were collected from beds 6, 7, and 8 of the type section of the Ellis group.

Vaginulina cetra, new species

Plate 3, figure 5

Test elongate, compressed, broad, with rather weak costae which are parallel to the sides and which become more pronounced in the adult portion; chambers flat, relatively high, and increasing gradually in height as added; sutures distinct, slightly limbate, and curved gently upward; wall calcareous, smooth; aperture terminal and at peripheral margin. Length of holotype, 1.07 mm; maximum breadth, 0.40 mm.

Remarks.—This species differs from *Vaginulina lancea*, n. sp., from the Ellis group, in that the cos-

tae on this species are poorly developed in the early portion and do not coalesce in the center. This species is also more slender.

Holotype.—Cushman Coll. No. 59741 from bed 7 of the type section of the Ellis group southeast of Bozeman, Montana.

Occurrence.—This species was noted in samples 6, 9, 12, 15, 16, and 17, which were all collected from beds 6 and 7 of the type section of the Ellis group.

GENUS **FRONDICULARIA** DEFRANCE, 1824

Frondicularia spatha, new species

Plate 3, figures 6a-d

Test elongate, broad, compressed, subrhomboidal in outline, with numerous vertical costae which are discontinuous, early portion of microspheric form coiled, megalospheric tests uniserial throughout; chambers inverted V-shaped, low, slightly inflated and all about the same height; sutures distinct, depressed, with sides curved toward proloculus; wall calcareous, smooth; aperture terminal, central in position. Length of holotype, 1.35 mm; maximum breadth, 0.50 mm; thickness, 0.13 mm.

Remarks.—This species is similar to *Frondicularia spatulata* TERQUEM, Jurassic of France, from which it differs in having more gently curved sutures without an upward projection in the center.

Holotype.—Cushman Coll. No. 59743, from bed 8 of the type section of the Ellis group southeast of Bozeman, Montana.

Occurrence.—This large distinctive species was found in samples 9, 22, and 25, which were collected from beds 6 and 8 of the type section of the Ellis group.

EXPLANATION OF PLATE 4

FIGURE	PAGE	FIGURE	PAGE
1a, b— <i>Pseudopolymorphina avia</i> , n. sp.	18	6a, b— <i>Guttulina fraga</i> , n. sp.	20
Holotype, Cushman Coll. No. 59747, 1a, side view, 1b, apertural view, × 70. From Bed 8, Ellis group, Bozeman, Montana.		Holotype, Cushman Coll. No. 59756, 6a, side view, 6b, apertural view, × 70. From Bed 7, Ellis group, Bozeman, Montana.	
2a, b— <i>Paleopolymorphina gemma</i> , n. sp.	18	7a, b— <i>Guttulina pera</i> , n. sp.	20
Holotype, Cushman Coll. No. 59749, 2a, side view, 2b, apertural view, × 60. From Bed 7, Ellis group, Bozeman, Montana.		Holotype Cushman Coll. No. 59757, 7a, side view, 7b, apertural view, × 70. From Bed 6, Ellis group, Bozeman, Montana.	
3a-f— <i>Ellisina spatula</i> , n. sp.	19	8a, b— <i>Guttulina stilla</i> , n. sp.	20
3a-c, Holotype, Cushman Coll. No. 59750, 3a, c, side views, 3b, apertural view, × 85. 3d-f, paratype, Cushman Coll. No. 59751, 3d, e, side views, 3f, apertural view, × 85. From Bed 7, Ellis group, Bozeman, Montana.		Holotype, Cushman Coll. No. 59758, 8a, side view, 8b, apertural view, × 70. From Bed 7, Ellis group, Bozeman, Montana.	
4a-d— <i>Eoguttulina pila</i> , n. sp.	19	9a, b— <i>Pseudopolymorphina pera</i> , n. sp.	18
4a, b, Holotype, Cushman Coll. No. 59752, 4-a, side view, 4-b, apertural view, × 70. 4c, Paratype, Cushman Coll. No. 59752A, side view, × 70. 4d, Paratype, Cushman Coll. No. 59753, side view, × 70. From Bed 7, Ellis group, Bozeman, Montana.		Holotype, Cushman Coll. No. 59748, 9a, side view, 9b, apertural view, × 70. From Bed 7, Ellis group, Bozeman, Montana.	
5a, b— <i>Eoguttulina vaga</i> , n. sp.	19	10a, b— <i>Eoguttulina axilla</i> , n. sp.	19
Holotype, Cushman Coll. No. 59754, 5a, side view, 5b, apertural view, × 70. From Bed 8, Ellis group, Bozeman, Montana.		Holotype, Cushman Coll. No. 59755, 10a, side view, 10b, apertural view, × 70. From Bed 17, Ellis group, Bozeman, Montana.	
		11a, b— <i>Patellina crista</i> , n. sp.	20
		Holotype, Cushman Coll. No. 59759, 11a, dorsal view, 11b, ventral view, × 85. From Bed 8, Ellis group, Bozeman, Montana.	

Fronidularia forma, new species

Plate 3, figures 7a-c

Test elongate, narrow, compressed, with faint vertical costae on some specimens; chambers low, inverted V-shaped, gradually increasing in height as added; sutures distinct and somewhat depressed; aperture terminal, central in position, and large. Length of holotype, 1.02 mm; maximum breadth, 0.40 mm; thickness, 0.10 mm.

Remarks.—This species is somewhat similar to *F. oolithica* TERQUEM, but differs from Terquem's species in being more elongate and having faint costae on well preserved microspheric forms.

Holotype.—Cushman Coll. No. 59745, from bed 8 of the type section of the Ellis group southeast of Bozeman, Montana.

Occurrence.—This very common species was found in samples 12, 13, 14, 15, 17, 18, 22, and 25, which were collected from beds 7 and 8 of the type locality of the Ellis group.

FAMILY POLYMORPHINIDAE

GENUS PALEOPOLYMORPHINA CUSHMAN
& OZAWA, 1930**Paleopolymorphina gemma**, new species

Plate 4, figures 2a, b

Test elongate, cylindrical; chambers in early portion in a spiral arrangement, later roughly biserial, each chamber farther from the proloculus, slightly inflated; sutures distinct, depressed, slightly curved upward and sloping at angles of about 60° to the sides of the test; wall calcareous, smooth; aperture terminal, radiate. Length of holotype, 1.03 mm; maximum breadth, 0.27 mm; thickness, 0.27 mm.

Remarks.—This species is somewhat similar to *Pseudopolymorphina subcylindrica* (HANTKEN), from which it differs in having the early chambers spiral and in being more slender.

Holotype.—Cushman Coll. No. 59749, from bed 7 of the type section of the Ellis group southeast of Bozeman, Montana.

Occurrence.—This species was found in sample 16 from bed 7 of the type section of the Ellis group.

GENUS PSEUDOPOLYMORPHINA CUSHMAN
& OZAWA, 1928**Pseudopolymorphina avia**, new species

Plate 4, figures 1a, b

Test globular, somewhat compressed, initial end pointed, apertural end rounded; chambers distinct, slightly inflated; sutures distinct, somewhat depressed; wall calcareous, smooth; aperture termi-

nal, radiate. Length of holotype, 0.50 mm; maximum breadth, 0.26 mm; thickness, 0.17 mm.

Remarks.—This species is similar to *Paleopolymorphina gaultina* (BERTHELIN), but differs in the arrangement of the early chambers and in being more highly inflated throughout.

Holotype.—Cushman Coll. No. 59747, from bed 8 of the type section of the Ellis group southeast of Bozeman, Montana.

Occurrence.—This very common species was found in samples 5, 6, 10, 12, 13, 14, 17, 22, 25, 30, 33, 34, 35, 36, 37, and 38, which were collected from beds 6, 7, 8, 13, 14, 15, and 17 of the type section of the Ellis group.

Pseudopolymorphina pera, new species

Plate 4, figures 9a, b

Test elongate, cylindrical; chambers in early portion short, later elongate, inflated; sutures faint, only slightly depressed; wall calcareous, smooth; aperture terminal, faintly radiate. Length of holotype, 0.76 mm; breadth and thickness, 0.20 mm.

Remarks.—This species differs from *Pseudopolymorphina digitata* (D'ORBIGNY), in having fewer chambers which are more highly inflated, and in being more slender.

Holotype.—Cushman Coll. No. 59748, from bed 7 of the type section of the Ellis group southeast of Bozeman, Montana.

Occurrence.—This common species was found in samples 15, 16, 17, 18, 22, 25, and 27, which were collected from beds 7 and 8 of the type section of the Ellis group.

GENUS ELLISINA, new genus

Test broad and compressed, curved in cross section, earliest chambers arranged at angles varying between 20° and 30° from the plane of the test, later chambers added at the outer margin in planes approximately 30° apart, making the entire test curved in cross section; chambers elongate, narrow, becoming larger gradually, inflated; sutures distinct, depressed, and slightly curved upward and outward; wall calcareous, finely perforate, smooth; aperture terminal, faintly radiate, large in most forms.

Genotype.—*Ellisina spatula*, n. sp., Ellis group near Bozeman, Montana.

Remarks.—This genus most closely resembles *Polymorphina*, but differs in that the chambers are not added in a single plane.

Occurrence.—This genus was found in samples 17 and 30, which were collected from beds 7 and 8 of the type section of the Ellis group southeast of Bozeman, Montana.

Ellisina spatula, new species

Plate 4, figures 3a-f

Test broad, compressed, curved in cross section; chambers elongate, narrow, and somewhat inflated; sutures distinct, depressed, and slightly curved upward and outward; wall calcareous, smooth; aperture terminal, rounded, and faintly radiate. Length of holotype, 0.47 mm; maximum breadth, 0.30 mm; maximum thickness, 0.14 mm.

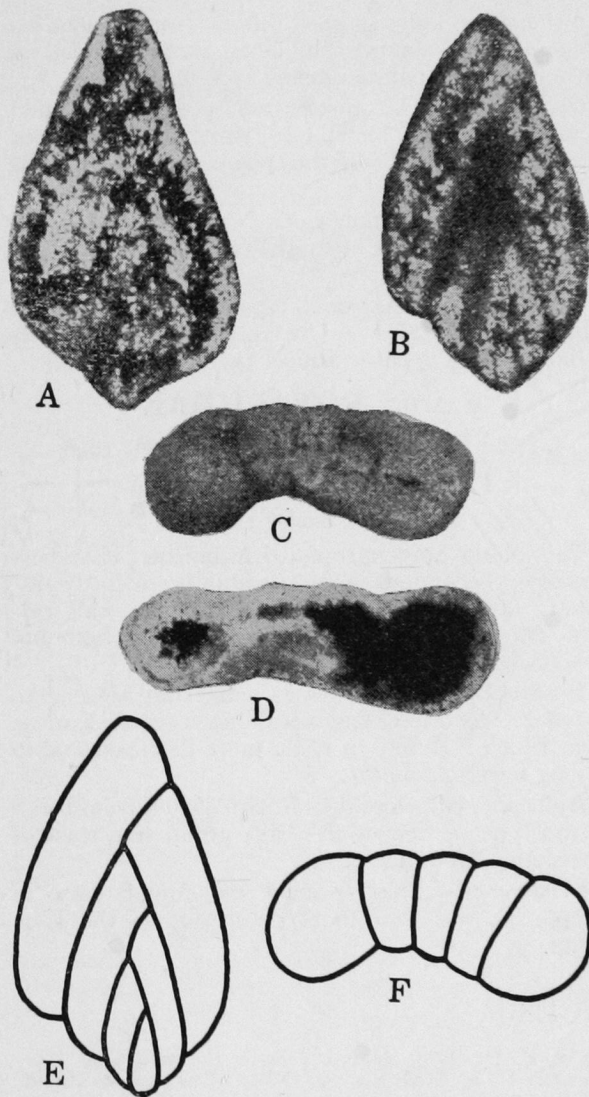


FIGURE 5.—*Ellisina spatula*, n. gen. and sp. A, B. Photographs of thin sections showing the arrangement of chambers of the test, $\times 90$. C. Cross section of the early portion of the test showing the curved shape, $\times 190$. D. Cross section of the middle portion of the test which is somewhat curved, $\times 190$. E. Line drawing of B showing the writer's interpretation of the arrangement of chambers, $\times 90$. F. Line drawing of C showing the writer's interpretation of the arrangement of chambers, $\times 190$.

Holotype.—Cushman Coll. No. 59750, from bed 7 of the type section of the Ellis group southeast of Bozeman, Montana.

Occurrence.—This species was found in samples 17 and 30, which were collected from beds 7 and 8 of the type section of the Ellis group.

GENUS **EOGUTTULINA** CUSHMAN & OZAWA, 1930

Eoguttulina pila, new species

Plate 4, figures 4a-d

Test elongate, rounded, sides nearly parallel, early portion rounded in megalospheric forms, somewhat pointed in microspheric forms; chambers large, early ones arranged in a spiral manner, later becoming uniserial, inflated; sutures distinct, depressed, and curved; wall calcareous, smooth; aperture terminal, radiate. Length of holotype, 0.80 mm; maximum breadth, 0.31 mm; thickness, 0.26 mm.

Remarks.—This species differs from *Eoguttulina polygona* (TERQUEM), from the Jurassic of France, in the larger size, more pointed initial end, and in having more highly inflated chambers.

Holotype.—Cushman Coll. No. 59752, from bed 7 of the type section of the Ellis group southeast of Bozeman, Montana.

Occurrence.—This species was found in samples 13, 17, 18, 22, 25, and 30, which were collected from beds 7 and 8 of the type section of the Ellis group.

Eoguttulina vaga, new species

Plate 4, figures 5a, b

Test elongate, slender, rounded; chambers inflated, early ones arranged in a spiral arrangement, later becoming uniserial and elongate; sutures depressed, curved in early portion, later straight; wall calcareous, smooth; aperture terminal, faintly radiate. Length of holotype, 0.99 mm; maximum breadth, 0.26 mm; thickness, 0.24 mm.

Remarks.—This species is somewhat similar to *Eoguttulina anglica* CUSHMAN & OZAWA, from which it differs in being more elongate and slender.

Holotype.—Cushman Coll. No. 59754, from bed 8 of the type section of the Ellis group southeast of Bozeman, Montana.

Occurrence.—This common species was found in samples 8, 16, 17, 22, 25, 30, and 31, which were collected from beds 6, 7, and 8 of the type section of the Ellis group.

Eoguttulina axilla, new species

Plate 4, figures 10a, b

Test elongate, subrhomboidal in outline, somewhat compressed; chambers in early portion low, later elongate, slightly inflated; sutures faint, curved; wall calcareous, smooth; aperture terminal, radiate. Length of holotype, 0.63 mm; maximum breadth, 0.30 mm; thickness, 0.19 mm.

Remarks.—This species differs from *Eoguttulina liassica* (STRICKLAND) in being broader and having chambers which are less inflated.

Holotype.—Cushman Coll. No. 59755, from bed 17 of the type section of the Ellis group southeast of Bozeman, Montana.

Occurrence.—This species was found only in sample 38 in bed 17 of the type locality and section of the Ellis group.

GENUS *GUTTULINA* D'ORBIGNY, 1839

Guttulina fraga, new species

Plate 4, figures 6a, b

Test elongate, broad, globular and somewhat compressed, both ends pointed; chambers large, inflated, and elongate; sutures depressed, curved; wall calcareous, smooth; aperture terminal, radiate. Length of holotype, 0.57 mm; maximum breadth, 0.30 mm; thickness, 0.20 mm.

Remarks.—This species is similar to *Guttulina franki* CUSHMAN & OZAWA, from which it differs in having a more pointed initial portion and longer chambers.

Holotype.—Cushman Coll. No. 59756, from bed 7 of the type section of the Ellis group southeast of Bozeman, Montana.

Occurrence.—This species was found in samples 17 and 27, which were collected from beds 7 and 8 of the type section of the Ellis group.

Guttulina pera, new species

Plate 4, figures 7a, b

Test broad, rounded in outline, compressed; chambers elongate; inflated, gradually increasing in size; sutures depressed, curved outward and upward; wall calcareous, smooth; aperture terminal, faintly radiate. Length of holotype, 0.47 mm; maximum breadth, 0.39 mm; thickness, 0.23 mm.

Remarks.—This species is similar to *Guttulina problema* D'ORBIGNY, from which it differs in having a more rounded initial portion and less inflated chambers.

Holotype.—Cushman Coll. No. 59757, from bed 6 of the type section of the Ellis group southeast of Bozeman, Montana.

Guttulina stilla, new species

Plate 4, figures 8a, b

Test small, globular, and somewhat compressed, initial end rounded, apertural end pointed; chambers elongate, narrow, slightly inflated; sutures depressed, gently curved upward and outward; wall calcareous, smooth; aperture terminal, radiate. Length of holotype, 0.30 mm; maximum breadth, 0.26 mm; thickness, 0.16 mm.

Remarks.—This species differs from *Guttulina irregularis* (D'ORBIGNY) in being more rounded in outline and less pointed at the apertural end.

Occurrence.—This distinctive species was found in samples 10, 12, 17, and 18, which were collected from beds 6, 7, and 8 of the type section of the Ellis group.

Holotype.—Cushman Coll. No. 59758, from bed 7 of the type section of the Ellis group southeast of Bozeman, Montana.

Occurrence.—This small species was found in samples 17 and 27, which were collected from beds 7 and 8 of the type section of the Ellis group.

FAMILY ROTALIIDAE

GENUS *PATELLINA* WILLIAMSON, 1858

Patellina crista, new species

Plate 4, figures 11a, b

Test plano-convex, rounded in outline; chambers elongate, becoming larger gradually, slightly inflated; sutures faint, slightly depressed; wall calcareous, smooth; aperture indistinct. Maximum breadth of holotype, 0.22 mm.

Remarks.—This species is somewhat similar to *Patellina dentata* TERQUEM, Jurassic of France, from which it differs in being more flattened and in having fewer chambers.

Holotype.—Cushman Coll. No. 59759, from bed 8 of the type section of the Ellis group southeast of Bozeman, Montana.

Occurrence.—This species was found only in sample 30, bed 8 of the type section of the Ellis group.

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