Ostracodes from the Upper part of the Sundance Formation of South Dakota, Wyoming and Southern Montana

GEOLOGICAL SURVEY PROFESSIONAL PAPER 243-A

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By FREDERICK M. SWAIN and JAMES A. PETERSON

SHORTER CONTRIBUTIONS TO GENERAL GEOLOGY, 1952, PAGES 1–18

GEOLOGICAL SURVEY PROFESSIONAL PAPER 243-A

Description and illustrations of a Late Jurassic fauna from the Redwater shale member, distribution of ostracodes in the Swift formation

UNITED STATES GOVERNMENT PRINTING OFFICE, WASHINGTON : 1952

UNITED STATES DEPARTMENT OF THE INTERIOR

Oscar L. Chapman, *Secretary*

GEOLOGICAL SURVEY

W. E. Wrather, *Director*

For sale by the Superintendent of Documents, U. S. Government Printing Office
Washington 25, D. C. - Price 35 cents

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By FREDERICK M. SWAIN and JAMES A. PETERSON

ABSTRACT

The Redwater shale member of the Sundance formation or the upper part of the Sundance of Late Jurassic age in South Dakota, Wyoming and Montana has yielded 16 species of Ostracoda representing: *Paraparchites* Ulrich and Bassler, *Eridoconcha* Ulrich and Bassler, *Cytherella* Jones, *Macrocypris* Brady, *Aparchitocythere* Swain and Peterson, n. gen., *Monoceratina* Roth, *Camptocythere* Triebel, *Leptocythere* Sars, *Cytherura* Sars, *Progonocythere* Sylvester-Bradley, *Protocythere* Triebel, *Cythereis* Jones. These species are described and illustrated.

Aparchitocythere n. gen., may have descended from *Ellipsella* Coryell and Rogatz of the Carboniferous and Permian or from a related genus, which in turn may have descended from *Graphiodactylus* Roth of the Devonian and Mississippian.

The Jurassic species of *Monoceratina* Roth, *Leptocythere* Sars, *Cytherura* Sars, and *Camptocythere* Triebel resemble *Aparchitocythere* in several features of the shell but *Monoceratina* at least seems to have originated in the Devonian from some genus other than *Graphiodactylus.* The Jurassic genus *Progonocythere* Sylvester-Bradley may lie in the evolutionary stock that contains *Savagella lindahli* (Ulrich) of the Mississippian. *Protocythere* Triebel of the Jurassic and Cretaceous may have descended from some species of *Basslerella* Kellett of the Carboniferous and Permian.

A new species here referred to *Cythereis* Jones may bear an ancestral relationship to *Amphissites* Girty or to a middle and late Paleozoic kirkbyid.

INTRODUCTION

This paper is the second dealing with marine Jurassic ostracodes from the western interior United States. The first article described species that occur in the Redwater shale member of the Sundance formation at the type locality (no. 1 on fig. 1) on Redwater Creek, south half, Sec. 2, T. 7 N., R. 1 E., Butte County, South Dakota (Swain and Peterson, 1951).

The present article deals with ostracodes obtained by Imlay and Loeblich from the Redwater shale member of the Sundance formation at other localities in South Dakota, Wyoming and southern Montana, and also lists ostracodes from the stratigraphically equivalent Swift formation of central Montana. Imlay (1947, p. 231, 1949, p. 79) correlated the Redwater shale member, which is the upper part of the Sundance, with the Oxfordian stage of Europe. A more complete study of the stratigraphic distribution of the ostracodes of the Redwater in wells in the Powder River Basin, eastern Wyoming, is being conducted by J. A. Peterson.

It is hoped later to describe the ostracodes collected by Imlay and Loeblich from the lower part of the Sundance formation of South Dakota, Wyoming and southern Montana and from the equivalent Rierdon formation of central Montana. In addition, papers on the Foraminifera are being prepared by A. R. Loeblich, Jr., and Helen Tappan (Mrs. A. R. Loeblich) (1950a, 1950b).

The Redwater shale member has yielded 16 species of Ostracoda, 14 of them new, representing 12 genera, one of which is new. Two genera are recorded for the first time in North America. The following species were obtained at the type locality of the Redwater shale member (Swain and Peterson, 1951): *Paraparchites*? sp., *Eridoconcha monopleura* Swain and Peterson, *Aparchitocythere loeblichorum* (Swain and Peterson), *Progonocythere hieroglyphica* Swain and Peterson, *P. crowcreekensis* Swain and Peterson, *Cytherura lanceolata* Swain and Peterson, *Monoceratina sundancensis* Swain and Peterson, *Leptocythere imlayi* Swain and Peterson, and *Cytheridea*? sp.

The doubtful *Paraparchites* and the *Eridoconcha,* as representatives of the Leperditellidae (a family which almost completely died out at the end of the Paleozoic era), form the most primitive elements of the Redwater fauna. They have not been found in the collections from other localities in the Redwater member or in the underlying portions of the Sundance. The Cytherellidae are represented in the Redwater by two species and the Cypridae by one species. The other ostracodes from the type locality are Cytheridae, mostly of primitive character with the terminal hinge-teeth and sockets weak or crenulate.

The following species were not found in the type locality of the Redwater shale member and are described here: *Cytherella paramuensteri, C. ventropleura, Macrocypris minutus, Aparchitocythere typica, Cythereis? zygoventralis, Protocythere quadricarinata,* and *Camptocythere elliptica.*

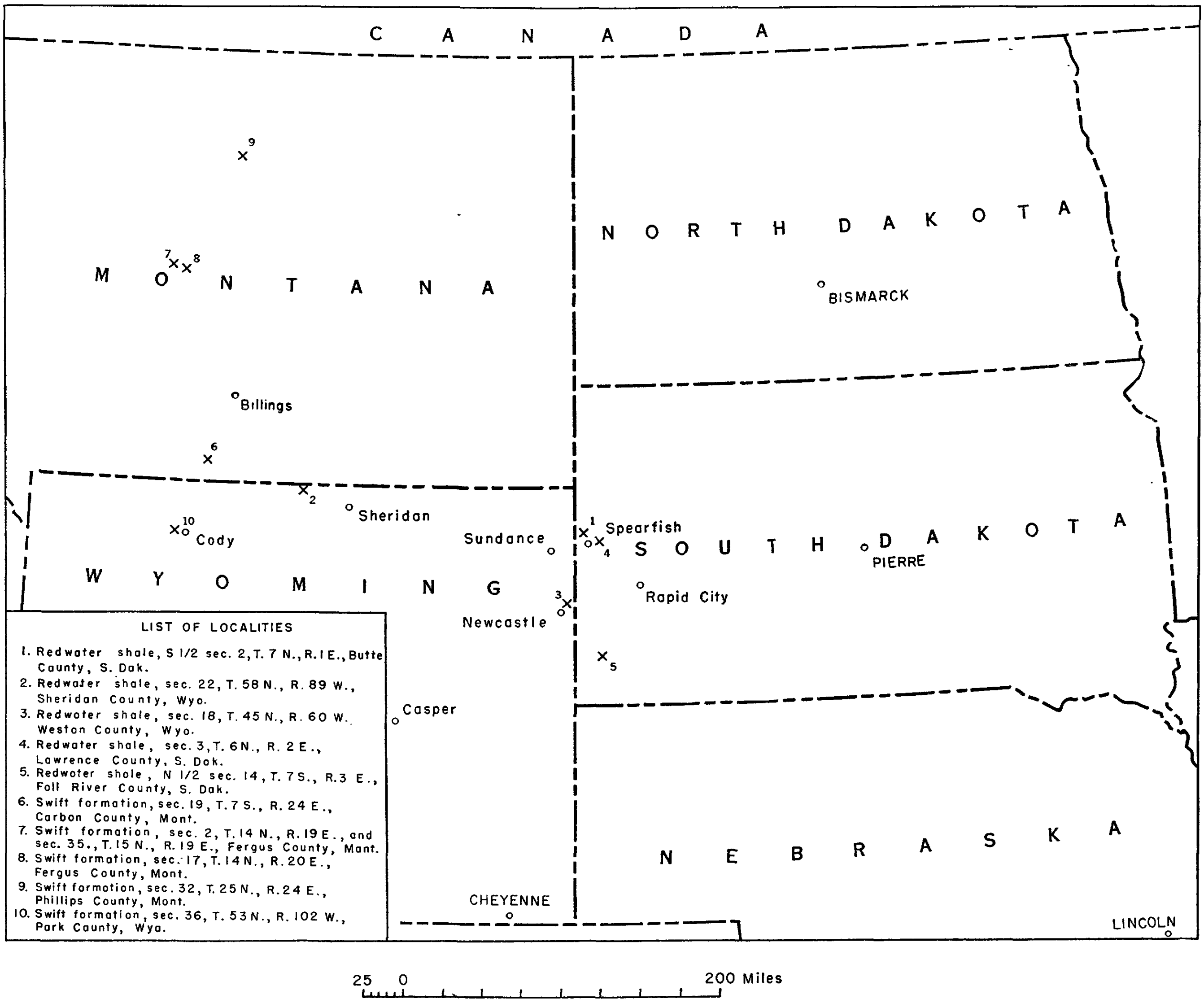

FIGURE 1.—Index map showing localities from which the ostracodes described or listed were obtained.

In the present material, ostracodes were most abundant in Red Gulch, Sheridan County, Wyoming. Descriptions of this and the other measured sections of the Redwater shale member from which ostracodes were obtained follow. Index numbers assigned to beds that were sampled (J–61p, etc.) indicate the occurrence of each species in the Descriptions of Species.

STRATIGRAPHIC SECTIONS

The following sections were measured and described by R. W. Imlay in 1945, and samples were collected for microfossils by R. W. Imlay and A. R. Loeblich in 1948:

Jurassic formations along east side of Red Gulch about 2½ miles south of Little Horn River in Sec. 22, T. 58 N., R. 89 W., Sheridan County, Wyoming. (Measured by R. W. Imlay and Wm. Saalfrank 1945.) Collected September 23, 1948 by R. W. Imlay and A. R. Loeblich, Jr. (Locality 2 on fig. 1.)

	Feet
Kootenai formation (basal part):	
Sandstone, fine-grained, grayish-white	4
Concealed	15
Sandstone, massive, cliff-forming, light-gray, strongly cross-bedded, irregular lower surface	20
Morrison formation:	
64. Shale, soft, light-red, upper 3 feet mostly greenish-gray	15
63. Sandstone, hard, light-gray, weathers yellowish	1½
62. Shale and some sandstone, yellowish-gray	4
61. Shale, soft, yellowish-gray	6
60. Sandstone, hard, grayish-white, weathers dark gray, forms ledge	3
59. Shale, soft, light greenish-gray	25
58. Sandstone, hard, grayish-white, weathers dark gray, forms ledge	4
57. Shale, partly silty, light-red and greenish-gray	24
56. Limestone, shaly, hard	1
55. Shale, light-red, becoming yellowish at top	7
54. Sandstone, fairly hard, light-gray	½

Morrison formation—Continued	Feet
53. Shale, yellow to gray, silty, several thin layers of fine-grained gray sandstone near top	3½
52. Shale, ribboned dark- and light-gray, silty	8
Total thickness of the Morrison formation	102½

Sundance formation:	Feet
Part of the Redwater shale member:	
51. Sandstone, light-yellow, soft, cross-bedded, forms cliff locally, upper part massive, lower part thin- to medium-bedded	23
50. Shale, sandy, thinly ribboned with gray shale, light-yellow, soft	5
49. Sandstone, hard, light-yellow, cross-bedded	1
48. Sandstone and shale, thinly bedded, soft	1
47. Sandstone, massive, very soft, dark-yellow, some glauconite	2
46. Sandstone, hard, light yellowish-gray	½ to 1½
45. Sandstone, massive, very soft, dark-yellow, some glauconite	7
44. Shale, sandy, yellowish-gray, soft, mostly covered	25
43. Sandstone, shaly, yellow	3
42. Shale, sandy, dark yellowish-gray	20
41. Limestone, silty, nodular	½
40. Shale, sandy, medium-gray	7
39. Shale, calcareous, medium-gray, abundant belemnites and *Gryphaea nebrascensis*	138
Total thickness of the Redwater shale member	233

Channel samples of Redwater shale member:	Height above base (feet)
J-61p	145–152
o	137–145
n	130–137
m	122–130
l	117–122
k	112–117
j	107–112
i	102–107
h	97–102
g	92–97
f	86–92
e	80–86
d	68–80
c	58–68
b	48–58
a	11–21

Hulett sandstone member:	Feet
38. Oolite, fine, sandy, light-brown, weathers yellowish brown, traces of fossils	6
37. Sandstone, massive, hard, forms top of cliff, light yellowish-gray, fine-grained, cross-bedded, weathers light gray	10
36. Oolite, coarse, yellowish-gray, weathers light gray, upper 6 inches soft and fossiliferous	1½
35. Sandstone, chunky, grayish-white, weathers whitish	3
34. Sandstone, calcareous, massive, light yellowish-gray, weathers buff, fine grained	7
33. Oolite, silty, gray	1
Total thickness of Hulett sandstone member	28½

Sundance formation—Continued	Feet
Stockade Beaver shale member:	
32. Shale, soft, brownish-gray, papery, fine, sandy, forms base of cliff	5
31. Shale, soft, brownish-gray, papery fine, sandy	15
30. Shale, soft, calcareous, medium-gray, abundant *Gryphaea nebrascensis*, some belemnites	76
29. Shale, calcareous, gray, contains several beds of slightly oolitic gray limestone, fossiliferous	5½
28. Shale, calcareous, gray. Sample J-60a from beds 28 and 29	1½
Total thickness of Stockade Beaver shale	103

Channel samples of Redwater shale member:	Height above base (feet)
J-60m	68–76
l	60–68
k	52–57
j	47–52
i	42–47
h	37–42
g	32–37
f	27–32
e	22–27
d	17–22
c	12–17
b	7–12

Gypsum Spring formation:	Feet
27. Shale, maroon, soft	41
26. Shale, light greenish-gray	5
25. Limestone, silty, white, soft, some thin beds of yellowish chert, upper foot weathers yellow, remainder weathers white	6
24. Shale, soft, light-red, some white layers in lower half, become light pink toward top, uppermost foot purplish	23
23. Clay-shale, soft, white	6
22. Limestone, shaly, greenish-gray	½ to 2
21. Shale, fairly soft, mostly purplish-pink; many layers are greenish-gray	4
20. Limestone, shaly at base and top, hard and ledge-forming in middle; mainly light gray with some pinkish layers, grades into underlying unit, fragmentary pelecypods at top	3½
19. Shale, soft, mostly maroon, some greenish-gray	13
18. Shale, soft, greenish-gray, some pink	12
17. Limestone, dolomitic, hard, dense, light-gray, leached	½
16. Shale, light-red to greenish-gray, soft	½
15. Limestone, dolomitic, hard, dense, light-gray	1
14. Limestone, oolitic, light-yellow	½
13. Shale, soft, light-red	½
12. Limestone, dolomitic, hard, dense, light-gray	1½
11. Shale, chunky, soft, pink to yellow, partly silty	2½
10. Limestone, thin-bedded, white, dense	1
9. Shale, soft, pink to light-green	½
8. Limestone, light yellowish-gray, dense, hard, laminated	1
7. Shale, soft, pink to gray, one 3-inch layer of dense white limestone in middle	5
6. Limestone, dense, hard, nearly white	1 to 1½
5. Shale, deep-red, soft, spotted with gray	1
4. Shale, light greenish-gray, soft, some layers nodular	5

Gypsum Spring formation—Continued

	Feet
3. Shale, partly silty, maroon, traces of greenish shale	10
2. Siltstone and silty shale, maroon, some spots of light green throughout	40
1. Siltstone, maroon, weathers pinkish, rests on leached to slightly cavernous maroon siltstone of Chugwater formation	8
Total thickness of Gypsum Spring formation	195½

Chugwater formation

The Red Gulch locality yielded most of the ostracodes described herein. A table showing distribution of the species in the Redwater shale member of the Sundance formation at Red Gulch faces p. 6.

Gypsum Spring and Sundance formations on west side of Stockade Beaver Creek, 5 miles NE of Newcastle in Sec. 18, T. 45 N., R. 60 W., Weston County, Wyoming. (Locality 3 on fig. 1.) Collected Sept. 21, 1948 by R. W. Imlay and A. R. Loeblich, Jr.

Sundance formation (part):

Redwater shale member (part):

	Feet
12. Shale, gray and greenish-gray; some layers are silty to sandy; contains many belemnites and some selenite; top not exposed.	
11. Sandstone, yellowish-gray, very soft, fine-grained	5
10. Shale, gray, partly silty, soft	18
9. Sandstone, white; weathers light gray, fairly soft, thick to thin-bedded, glauconitic; includes some thin beds of gray shale and shaly sandstone	7

Channel samples of Redwater shale member:

	Height above base (feet)
J–52f	81–88
e	74–81
d	33–41
c	28–33
b	7–25

Lak member:

	Feet
8. Siltstone and sandstone, mostly maroon; a 2-foot bed of greenish gray siltstone 15 feet below top in a sharp contact with overlying glauconitic sandstone	80

Iulett sandstone member:

	Feet
7. Sandstone, white, massive, soft, very fine grained; grades upward into siltstone and then into a foot of soft green shale at top	6
6. Siltstone, shale and some fine-grained sandstone, greenish gray to yellowish gray, weathering pink to buff	9
5. Sandstone, thick-bedded; forms sheer cliff; ripple-marked, light grayish yellow, weathering buff, glauconitic	30
4. Shale, sandy, interbedded with shaly to thin-bedded sandstone; shale is greenish gray; sandstone is yellow; grades into adjoining units; forms recess in cliffs; contains *Camptonectes*	12
3. Sandstone, medium- to thick-bedded with some shaly partings, ripple-marked, light grayish yellow, weathering buff, glauconitic; grades into underlying unit	12

Sundance formation—Continued

Stockade Beaver shale member:

	Feet
2. Shale, dark gray, soft, fissile; contains some nodules of limestone in lower 10 feet and some limonitic shaly sandstone in lower foot; selenite crystals and *Camptonectes* present	63

Channel samples of Stockade Beaver shale member:

	Height above base (feet)
J–51j	55–63
i	50–55
h	45–50
g	39–45
f	34–39
e	27–34
d	22–27
c	16–22
b	8–16
a	0–8

Gypsum Spring formation:

	Feet
1. Gypsum, white, granular, bedded; forms low cliff; rests sharply on the slightly irregular surface of the red beds of the Spearfish formation	8–12

Spearfish formation:

Sundance and Gypsum Spring formations one mile north-northeast of center of Spearfish in Sec. 3, T. 6 N., R. 2 E., Lawrence County, South Dakota. Collected September 21, 1948 by R. W. Imlay and A. R. Loeblich, Jr. (Locality 4 on fig. 1.)

Morrison formation:

Mostly covered. Basal beds consist of fine-grained, pseudo-oolitic, yellow sandstone.

Sundance formation:

Redwater shale member:

	Feet
18. Shale, dark-gray fissile; contains some very thin beds of fine-grained, greenish-gray sandstone	15
17. Limestone, shaly, and sandy shale, fossiliferous	8
16. Shale, dark-gray; some silty beds in lower 25 feet; belemnites abundant	65
15. Sandstone, yellow, soft	2
14. Shale, dark-gray	11
13. Sandstone, yellow, soft	2
12. Shale, greenish-gray, silty	7
11. Sandstone, gray, soft, glauconitic	½

Channel samples of Redwater shale member:

	Height above base (feet)
J–47h	95–106
g	85–95
f	77–85
e	69–77
d	59–69
c	49–59
b	21
a	1–8

Lak member:

	Feet
10. Sandstone, fine-grained, and siltstone, mostly maroon; some greenish layers and spots; weathers light pink	60

Hulett sandstone member:

	Feet
9. Sandstone and silty shale, soft, yellowish-gray	17+
8. Shale, silty, greenish gray	6
7. Sandstone, fine-grained, mostly yellow, some pinkish	4

Sundance formation—Continued	Feet
Hulett sandstone member—Continued	
6. Shale, silty, and siltstone, light red and yellowish, weathering pinkish	11
5. Shale, sandy, greenish gray to pinkish; some pink shaly sandstone	12
4. Sandstone, thick- to medium-bedded, mostly pink to yellow, fine-grained, ripple-marked, glauconitic	6
3. Shale, greenish-gray, partly sandy, poorly exposed	12
2. Sandstone, thick- to medium-bedded, mostly pink to yellow, fine-grained, ripple-marked, glauconitic	29
Stockade Beaver shale member:	
1. Shale, soft, brownish gray in lower 15 feet, dark gray above; weathers yellowish gray; a few pitted pebbles of a very dense metamorphic rock in basal foot	60

Channel samples of Stockade Beaver shale member:

	Height above base (feet)
J-46h	55–60
g	45–53
f	38–45
e	30–38
d	23–30
c	14–23
b	6–14
a	0–6

Samples from Stockade Beaver member are channel samples.

Gypsum Spring formation (part):	
Gypsum, bedded, white, sugary	1
Shale, yellowish-gray, soft. Sample J-45	2

Sundance formation about three miles west-northwest of Minnekahta in the N½ Sec. 14, T. 7 S., R. 3 E., Fall River County, South Dakota. Collected September 22, 1948 by R. W. Imlay and A. R. Loeblich, Jr. (Locality 5 on fig. 1.)

Sundance formation:	Feet
Redwater shale member:	
15. Shale, dark-gray, soft, fissile; upper part has many ledges of limestone from a few inches to 2 feet thick, belemnites common near base. Overlain, apparently along a fault contact, by about 15 feet of fossiliferous gray limestone that grades up into hard fine-grained white sandstone that is overlain by shale typical of the Morrison formation. Estimated thickness of the shale	80
14. Sandstone, shaly, light gray, glauconitic, ripple-marked, poorly exposed	18
13. Sandstone, greenish gray, soft, glauconitic	9
Incomplete thickness of Redwater shale member	107

Channel samples of Redwater shale member:

	Height above base (feet)
J-56c	18–23
d	23–30
b	13½
a	9

Sundance formation—Continued	Feet
Lak member:	
12. Shale, maroon, soft	18
11. Sandstone, maroon, massive	4
10. Shale, grayish-green	5
9. Siltstone and shale, maroon	6
8. Sandstone, salmon-pink, massive	12
7. Siltstone and shale, maroon	15
Total thickness of Lak member	60
Hulett sandstone member:	
6. Shale, medium gray to greenish gray	10
5. Sandstone, nearly white, medium-bedded at base, shaly in middle, and thin-bedded at top, medium- to fine-grained, ripple-marked, weathers light gray	22
Total thickness of Hulett sandstone member	32

Sample J-55 is from zone 6, 22 to 32 feet above base of Hulett sandstone member.

Stockade Beaver shale member:	
4. Shale, dark gray, some limonitic nodules and very thin layers of calcareous sandstone in lower 5 feet. Lower foot characterized by fossiliferous limonitic nodules and by subangular pebbles from ¼ to ½ inch in diameter of a very hard, dense metamorphic rock. U.S.G.S. Mes. Loc. 19558 from basal 5-foot zone contains *Eumicrotis curta* (Hall), *Corbicellopsis*? *inornata* (Meek and Hayden), *Quenstedtia sublevis* (Meek and Hayden), and *Astarte*? *fragilis* Meek and Hayden. U.S.G.S. Mes. Loc. 19559 collected from the entire unit contains *Pentacrinus asteriscus* Meek and Hayden, *Eumicrotis orbiculata* (Whitfield), *E. curta* (Hall), *Camptonectes extenuatus* (Meek and Hayden), *Pleuromya subelliptica* (Meek and Hayden), *Corbicellopsis? inornata* (Meek and Hayden), *Ostrea* sp., and *Pachyteuthis* sp	48

Channel samples of Stockade Beaver shale member:

	Height above base (feet)
J-54g	35–41
f	31–35
e	25–31
d	17–25
c	11–17
b	6–11
a	0– 6

Gypsum Spring formation:	
3. Sandstone, white, medium-bedded, medium-grained, grades into underlying beds	2½
2. Sandstone, red to salmon-pink, massive, cliff-forming but fairly soft, coarsely cross-bedded, moderate- to fine-grained, some fine chert grit throughout, weathers brick red; 1 foot of white sandstone about 2 feet below top	42
1. Sandstone in two massive beds; lower bed pink to yellow; upper bed yellow; rather soft, contains chert grit and some pebbles as much as ½ inch in diameter	3
Total thickness of Gypsum Spring formation	47½

Distribution of Ostracoda in the Redwater shale member of the Sundance formation, Red Gulch section, Sheridan County, Wyo.

[Locality 2 on fig. 1, samples 1–61a–p.]

		a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	p
Cytherella paramuensteri, n. sp.	Number of valves (complete shells).					9 (1)	[1] 74(8)	186(5)	369(116)	59	135(29)	243(36)	15(7)	116(57)	68(33)		
	Adult male valves					4	40	140	206	26	84	148		38	10		
	Adult female valves						8	2	33	19	28	19	14	70	46		
	Immature valves					5	26	144	130	14	23	76	1	8	12		
Cytherella ventropleura, n. sp.	Number of valves (complete shells).						6(2)	28(13)		3(1)		5(2)					
	Adult male valves																
	Adult female vales																
	Immature valves																
Macrocypris minutus, n. sp.	Number of valves (complete shells).					2(1)			14(7)	12(5)	22(11)	49(24)					
	Adult male valves																
	Adult female valves																
	Immature valves									2	8	4					
Aparchitocythere typica, n. gen., n. sp.	Number of valves (complete shells).				168(60)		8(2)	24(6)	132(51)				61(30)	280(139)	111(55)	73(35)	103(51)
	Adult male valves				90		8	10	94				47	224	95	?64	73
	Adult female valves				37			4	20				4	26	2	?2	18
	Immature valves				41			10	18				10	30	14	7	?12
Aparchitocythere loeblichorum (Swain and Peterson).	Number of valves (complete shells).	49(23)															
	Adult male valves	31															
	Adult female valves	18															
	Immature valves																
Monoceratina sundancensis Swain and Peterson.	Number of valves (complete shells).					276(122)	3	28(7)		94(38)	194(90)						
	Adult male valves																
	Adult female valves																
	Immature valves																
Camptocythere elliptica, n. sp.	Number of valves (complete shells).						2	21(9)	51(23)	28(12)	49(23)	176(53)	1	12(6)	44(22)		
	Adult male valves							4	?4		?2	?7			?10		
	Adult female valves							17	?47	?28	?47	?169	?1	?12	?27		
	Immature valves														?7		
Leptocythere imlayi Swain and Peterson.	Number of valves (complete shells).								4(2)	6(1)	43	10	1	1	6		
	Adult male valves									3	22	1		1			
	Adult female valves								4	3	17	7	1		6		
	Immature valves										4	2					
Cytherura? lanceolata Swain and Peterson.	Number of valves (complete shells).					19(8)		4(2)	53(26)	17(8)	44(22)	142(71)		2(1)			
	Adult male valves																
	Adult female valves																
	Immature valves					?3			?2	?4		?6					
Progonocythere hieroglyphica Swain and Peterson.	Number of valves (complete shells).		8(4)														
	Adult male valves		?2														
	Adult female valves		?6														
	Immature valves																
Progonocythere crowcreekensis Swain and Peterson.	Number of valves (complete shells).		8(4)	26(13)	57(16)	2(1)											
	Adult male valves		2	18	34												
	Adult female valves		6	4	12												
	Immature valves			4	11	?2											
Protocythere quadricarinata, n. sp.	Number of valves (complete shells).			12(4)	11												
	Immature valves			1	1												
Cythereis? zygoventralis, n. sp.	Number of valves (complete shells).							80(25)	20(2)		156(69)	186(33)	18(9)				
	Adult male valves							74	14		106	152	16				
	Adult female valves								2		26	18	2				
	Immature valves							6	4		24	16					

[1] The "number of valves" includes in each instance both single valves and whole specimens; the numbers in parentheses are of complete shells. Numbers of male and female valves are given where dimorphism is recognized, but in *Camptocythere elliptica* the figures are tentative because of difficulty in distinguishing male dimorphs from immature specimens. For example, *Cytherella paramuensteri* is represented at locality J–61f by 74 valves of which 16 are 8 complete shells and the remaining 58 are separated valves. Forty of the total of 74 valves are interpreted as adult males, 8 are adult females and 26 are immature valves.

Samples from Swift formation of Montana

Area and sample	*Height (in feet) above base of formation*
Southwest corner of Red Dome, east of Bridger, in Pryor Mountains, Sec. 19, T. 7 S., R. 24 E., Carbon County, Mont. (Locality 6 on fig. 1.)	
Sample: J–10a	At base
10b	Upper part of 7-ft basal sandstone bed
10c	15
11a	20–23
11b	26
11c	29-33
11d	40
12a	40–45½
12b	45½–51

Samples from Swift formation of Montana—Continued

Area and sample	*Height (in feet) above base of formation*
Along east side of road, ½ to 1 mi north of gypsum factory in Sec. 2, T. 14 N., R. 19 E., and Sec. 35, T. 15 N., R. 19 E., near Heath, Fergus County, Mont. (Locality 7 on fig. 1.)	
Sample J–14a	6–11
One mi southwest of Piper on the northwest corner of the escarpment due east of Bacon Ranch, Sec. 17, T. 14 N., R. 20 E., Fergus County, Mont. (Locality 8 on fig. 1.)	
Sample J–19	Basal layers
One mi southwest of Landusky, Sec. 32, T. 25 N., R. 24 E., Little Rocky Mountains, Phillips County, Mont. (Locality 9 on fig. 5.)	

Sample from Swift formation of Montana—Continued

Area and sample	*Height (in feet) above base of formation*
One mi southwest of Landusky—Continued	
Sample: J–22a	1
22b	4
22c	9
22d	13
22f	22
22g	25
22h	29
22j	37
22l	50
Gorge of Shoshone River, 2 mi west of Cody, Wyoming. (Locality 10 on fig. 1.)	
Sample: J–43b	5–10
43c	10–15

Distribution of ostracodes in the Swift formation of Montana

[R=1-5, LC=6-15, C=16-25, A=26-50, and VA=more than 50 specimens.]

	J–10			J–11				J–12		J–14	J–19	J–22									J–43	
	a	b	c	a	b	c	d	a	b			a	b	c	d	f	g	h	j	l	b	c
Cytherelloidea sp	R																					
Cytherelloidea? sp																					LC	
Cytherella paramuensteri				C	C	R	R		LC	LC											LC	
Macrocypris minutus										LC	R			R		R						
Aparchitocythere typica		A	LC			R	LC	LC		LC											A	A
A. cf. *A. loeblichorum*															LC							
Monoceratina sundancensis					C	LC	LC			C	LC	R				LC			C			
Leptocythere imlayi										A	LC								C			
Cytherura? *lanceolata*						C	A			C						R						
C.? sp																						R
Progonocythere hieroglyphica.	R										LC		LC	R	R	LC	VA				A	
P. crowcreekensis	LC	C	R								LC		LC					A				LC
P.? sp																				LC		
Protocythere quadricarinata		LC	R													R	A					
Bythocypris? sp												A										
new genus resembling *Theriosynoecum.*										R												
new genus resembling *Orthonotacythere*										R	R											
new genus resembling forms in Rierdon fm													LC		R		VA					

ANCESTRAL RELATIONSHIPS OF THE REDWATER OSTRACODES

The late Paleozoic and the described Mesozoic ostracodes are, for the most part, very different. Perhaps the keys to their interrelationships lie in the almost entirely unknown Triassic faunas. Among the very few genera of Permian ostracodes that also occur in Jurassic rocks are *Paraparchites* Ulrich and Bassler, *Eridoconcha* Ulrich and Bassler, *Bairdia* McCoy, *Cytherella* Jones, *Bythocypris* Brady, *Macrocypris* Brady, *Pontocypris* Sars, and *Monoceratina* Roth. The Permian genus *Tomiella* Spizharsky is very close to, if not the same as, *Limnocythere* Brady of the Cenozoic.

Doubt can be raised in practically all of these instances as to the equivalence of the Paleozoic genera and those in younger rocks, particularly because of the generally simpler muscle-scar patterns of the Paleozoic species. If they are not congeneric however, the Paleozoic species and those of the Mesozoic and Cenozoic are strikingly homeomorphic. Until the Triassic ostracodes are better known and the details of shell structure in the late Paleozoic ostracodes have been more thoroughly studied, comparisons between many late Paleozoic and Mesozoic ostracodes will remain largely subjective. The following tentative suggestions concerning the relationships of several groups of ostracodes are based on Swain's studies of various ostracode faunas, and examination of type specimens in the United States National Museum.

The Cytherellidae of the Mesozoic do not differ in principal shell features from those of the Permian. The distinction between *Cavellina* Coryell (emended Kellett, 1935, p. 144) in which the posterior inner transverse ridge of the females is long, and *Cytherella* Jones in which this ridge is shorter, is very obscure. *Cytherella paramuensteri*, n. sp. of the Upper Jurassic has the posterior ridge and corresponding external transverse depression extending from the dorsal to the ventral margin, and if the species had been found in the Paleozoic would very likely have been referred to *Cavellina*. Swain feels that there is little value in retaining *Cavellina* and recommends that it be discarded or reduced to the status of a subgenus.

The Bairdiidae also seem to continue with relatively little change from the Permian into the Mesozoic. The hinge structures of the Mesozoic *Bairdia* are poorly known, and many of the species may eventually be referred to *Bairdoppillata* Coryell, Sample and Jennings, in which denticulations occur on the selvage along the dorsal slopes.

Marine Cypridae, such as *Paracypris* Sars, are present both in Paleozoic and in younger rocks and, although the muscle scars of the Paleozoic species are simpler than those in the Mesozoic and Cenozoic species (Scott, 1944, p. 163), there is little to distinguish them generically. The marine Cypridae are not important elements in most fossil ostracode faunas.

The roots of the Cytheridae, which dominate post-Paleozoic marine ostracode faunas, are obscure, but it seems very possible that the family is polyphyletic. Kellett (1935, p. 155) concluded that the Pennsylvanian and Permian *Basslerella* Kellett is the direct ancestor of *Cytheridea* because of the general shape, weakly crenulate hinge, and calcified inner lamellae of the former. Swain examined types of species of *Basslerella*, and observed these features in *B. crassa* Kellett (the type of the genus), but feels that the other species are less certainly representative of the Cytheridae and perhaps are closer to the Cypridae.

Ellipsella distenta Kellett (1933, p. 82, pl. 13, figs. 18–20) from the Pennsylvanian Howard limestone of Kansas is much like *Aparchitocythere* Swain and Peterson, n. gen., in outline, nearly straight hinge margin, and in the slight but clear differentiation along the hinge of the left valve to form weak terminal teeth (rather than left valve sockets in *Aparchitocythere*), an interterminal weak, perhaps slightly crenulate bar and a weak groove dorsal to the bar. The writers would orient the species so that the more truncated, higher end is posterior, making the right valve the larger and placing the weak sulcus anterior to midlength. Other specimens figured by Kellett from the lower Permian (1933, pl. 13, figs. 14–16) may represent a different species. *Ellipsella* (Coryell and Rogatz, 1932) is placed in the Kloedenellidae by Kellett who states however that, "* * * it might well belong in the Glyptopleuridae, the hingement apparently being similar to that of the latter genus [family]" (Kellett, 1933, p. 82). The present writers offer another suggestion: that its outline and submedian pit or weak sulcus ally *Ellipsella* with *Graphiodactylus* Roth for which Kellett (1936, p. 772) proposed the family Graphiodactylidae. We suggest that *Aparchitocythere*, n. gen., representing one section of Jurassic Cytheridae, is related to *Ellipsella* Coryell and Rogatz of the Pennsylvanian and Permian, which in turn may be descended from *Graphiodactylus* Roth of the Devonian and Mississippian.

The holotype of *Kirkbya lindahli* Ulrich from the Warsaw limestone, Mississippian, at Columbia, Illinois, is the genoholotype of *Savagella* Geis (1932, p. 168) of the family Kirkbyidae. The specimen, here called a left valve, is subquadrate with an abraded but straight, apparently simple hinge; the anterior cardinal angle is much more obtuse than the posterior; the external surface has an anteromedian node and postjacent furrow, a well-developed marginal rim, and coarse surface reticulations. The valve interior is filled with matrix. This species or a related form may lie in the ancestral stock of the Jurassic genus *Progonocythere* Sylvester-Bradley which is represented in the Redwater fauna by *P. hieroglyphica* Swain and Peterson and *P. crowcreekensis* Swain and Peterson. The hinge of *Progonocythere* is more advanced in that it bears terminal crenulate elements.

Protocythere Triebel, which is represented by several species in the Cretaceous, and now has been found in the Redwater shale member of the Sundance formation, may be descended from *Basslerella* Kellett. As stated above *Basslerella* is believed by Kellett to be ancestral to the cytherideids of the Mesozoic. *Protocythere* closely resembles *Haplocytheridea* Stephenson and other typical cytherideids in hingement and general form, but differs in its longitudinal pattern of ridges and more compressed posterior end.

The ancestral relationships of the Redwater species of *Monoceratina* Roth, *Leptocythere* Sars, *Cytherura* Sars, *Camptocythere* Triebel, and *Cythereis* Jones are obscure. The Redwater species of the first four genera have in common weak ventral alae or swellings, and all five genera resemble *Aparchitocythere*, n. gen., whose left valve is the larger, but whose right valve extends beyond the left along the hinge and the hinge bears only weak simple terminal teeth and sockets. Whether these similarities are phyletic or merely homeomorphic only additional study of material from older deposits will reveal. *Monoceratina* is found in rocks as old as Middle Devonian. It is not clear whether the Mesozoic and Cenozoic "*Monoceratina*" are congeneric with those of the Paleozoic. Swartz (1936, p. 554) placed the genus in the Acronotellidae, but post-Paleozoic species are generally placed in the Cytheridae.

The ancestry of *Cythereis* is also obscure. The females of *C.*? *zygoventralis*, n. sp. are very similar in general shape, marginal rim and strong longitudinal ridges in the ventral half, to some species of *Amphissites* Girty of the middle and late Paleozoic. The hinge of *Cythereis*, consisting of an anterior socket and tooth, interterminal bar or groove and posterior socket or tooth, is the most advanced type of ostracode hinge. Indirect support of a possible relationship of the genus to *Amphissites* is that the hinge of the latter is relatively much more advanced than that of other Paleozoic ostracodes, and typically bears terminal sockets and teeth (Kellett, 1933, p. 93). The present writers would reverse the orientation of *Amphissites* used by Kellett and refer to the more broadly rounded end as anterior. The writers believe that there may be an ancestral relationship between *Amphissites* and *Cythereis*? *zygoventralis* but, as explained in the description of the species, it is not clear whether *C.*? *zygoventralis* represents *Cythereis* or a new genus.

DESCRIPTION OF SPECIES

Order OSTRACODA Latreille, 1802

Suborder PLATYCOPA Sars, 1866

Family CYTHERELLIDAE Sars, 1866

Genus CYTHERELLA Jones, 1849

Cytherella paramuensteri Swain and Peterson, n. sp.

Plate 1, figures 1–7

Shell subquadrate in lateral view; dorsal margin nearly straight, about two-thirds of shell length; ventral margin slightly concave medially, subparallel to dorsum; terminal margins broadly rounded, posterior truncate below midheight. Right valve larger than left, overlapping and extending beyond the other around entire periphery, most strongly along dorsum and ventrum. Valves compressed, but with female dimorphs inflated in posterior fifth. Surface very slightly depressed in mid-dorsal region; a small pit, the external expression of the muscle scar, lies just dorsal to midheight; general surface smooth except for very minute, closely spaced pits on marginal portions of valves.

Margin of right valve grooved for reception of edge of left; along hinge, groove slightly deeper than elsewhere, and posteriorly very shallow. Muscle scar a small, slightly dorsomedian elevation, consisting of four or five longitudinally elongated spots. Inner lamellae and pore canals lacking.

Length of holotype (U.S.N.M. 117957), a female shell, 0.83 mm, height 0.45 mm, thickness 0.32 mm. Length of a male paratype (U.S.N.M. 117958, pl. 1, fig. 2) 0.72 mm, height 0.30 mm, thickness 0.26 mm.

Relationships.—This species closely resembles *C. muensteri* (Roemer) of the Cretaceous in the tiny surface pits of the females, but is more subquadrate. It is also closely similar to other species of *Cytherella* that occur in the Lower Cretaceous and Upper Jurassic of the Gulf of Mexico region (Alexander, 1929, pp. 47–49; Swain, 1949, pl. 3), particularly *C. scotti* Alexander and *C. comanchensis* Alexander, but dimorphism in these species has not been well demonstrated. Adult specimens apparently are far outnumbered by immature molts in the present collections. Among the adults the smaller, less convex, males are more numerous than the females.

Occurrence.—(1) Upper part of the Sundance or Redwater shale member of the Sundance formation, Red Gulch, Sec. 22, T. 58 N., R. 89 W., Sheridan County, Wyoming; localities J–61e–n. (2) Swift formation, Red Dome, Sec. 19, T. 7 S., R. 24 E., Carbon County, Montana; J–11a–d, J–12b. (3) Swift formation, near Heath, Sec. 2, T. 14 N., R. 19 E. and Sec. 35, T. 15 N., R. 19 E., Fergus County, Montana; J–14a. (4) Swift formation, Shoshone River Gorge, 2 miles west of Cody, Wyoming; J–43b. (5) Specimens probably representing this species also occur in the lower part of the Sundance formation in Wyoming.

Cytherella ventropleura Swain and Peterson, n. sp.

Plate 1, figures 10–12

Shell minute, ovate in lateral view; highest near anterior end; dorsal and ventral margins slightly convex, ventrum straightened medially; anterior margin broadly rounded, posterior margin narrower and slightly extended medially. Right valve larger than left, extending beyond the other most noticeably along ventrum. Valves compressed except for postventral broad longitudinal swelling on surface of each valve; general surface very finely pitted.

Hingement consists of simple groove in right valve for reception of edge of left. Muscle scar not clearly seen but seems to consist of a large circular spot situated near anterior end of postventral external swelling, and well in front of midlength. Inner lamellae lacking.

Length of holotype (U.S.N.M. 117963) 0.27 mm, height 0.19 mm, thickness 0.12 mm.

Relationships.—The posteroventral longitudinal swelling serves to distinguish this species. It is also distinguished by its small size, and the present specimens possibly represent immature molts. The hingement, overlap relationships, and lack of inner lamellae ally the species with *Cytherella* Jones.

Occurrence.—Upper part of the Sundance or Redwater shale member of the Sundance formation, Red Gulch, Sec. 22, T. 58 N., R. 89 W., Sheridan County, Wyoming; J–61f, g, i, k.

Suborder PODOCOPA Sars, 1866

Family CYPRIDAE Baird, 1846

Genus MACROCYPRIS Brady, 1867

Macrocypris minutus Swain and Peterson, n. sp.

Plate 1, figures 13–16

Shell sublanceolate in side view; highest about one-third from anterior end; dorsal margin moderately convex, slightly truncate behind and in front of point of greatest height; ventral margin nearly straight; anterior margin rounded, extended medially; posterior margin bluntly acuminate, strongly extended below. Right valve larger than left, extending beyond the other along ventrum and along dorsal slopes. Valves compressed, thickest medially.

Hingement simple; hinge surface of left valve slightly beveled above, along dorsal slopes, for reception of overlapping edge of right. Inner lamellae fairly broad; line of concrescence and inner margin coincide. Muscle scar not clearly observed but appears to consist of a slightly dorsomedian group of four spots of which the dorsal two are the largest. Neither radial nor normal canals were observed.

Length of holotype (U.S.N.M. 117965) 0.39 mm, height 0.18 mm, thickness 0.07 mm.

Relationships.—This species is less elongated and smaller than most other described members of *Macrocypris*. The overlapping right valve relates it to this genus although living species are much larger. Specimens described by Cooper (1946, pp. 61, 62) from the Pennsylvanian and by Alexander (1929, p. 59) from the Cretaceous are generally smaller than 1 mm, whereas living species are as much as 3 mm or more in length.

Occurrence.—(1) Upper part of the Sundance or Redwater shale member of the Sundance formation, Red Gulch, Sec. 22, T. 58 N., R. 89 W., Sheridan County, Wyoming; J–61e, h–k. (2) Swift formation, near Heath, Sec. 2, T. 14 N., R. 19 E. and Sec. 35, T. 15 N., R. 19 E., Fergus County, Montana; J–14a. (3) One mile southwest of Landusky, Sec. 32, T. 25 N., R. 24 E., Phillips County, Montana; J–22c, f.

Family CYTHERIDAE Baird, 1850

Genus APARCHITOCYTHERE Swain and Peterson, new genus

Shell subovate to subquadrate; hinge margin nearly straight, frequently occurring mostly posterior to point of greatest height; ventrum gently convex to sinuous; terminal margins broadly rounded. Left valve larger than right, but right overlaps left along hinge. Valves strongly convex. Surface not strongly ornamented.

Hinge of left valve consists of a terminal short elongate socket-groove, and an interterminal narrow bar with weak groove behind it. Hinge of right valve consists of corresponding terminal elongate tooth elevations formed of valve edge, and an interterminal groove. Inner lamellae distinct and heavily calcified but narrow; line of concrescence and inner margin slightly separated. Radial canals few and widely spaced; normal canals likewise few. Muscle scar consists of a median vertical row of three or four spots, and two more anterior spots; a low obscure transverse ridge lies on valve interior just behind muscle scar. In the type species, female dimorphs larger and more subquadrate than males.

Type species.—*Aparchitocythere typica* Swain and Peterson, n. sp.

Geologic Range.—Upper Jurassic. The species described as *Apatocythere*? *loeblichorum* Swain and Peterson (1951) from the Redwater shale member of the Sundance formation are referred to *Aparchitocythere* (see p. 11). An undescribed species of the genus occurs in the lower part of the Sundance formation.

Aparchitocythere typica Swain and Peterson, n. sp.

Plate 1, figures 8, 9, 17, 18, 21, 22

Shell subovate to subquadrate in side view. Dimorphism prominently exhibited, with males shorter, more ovate in outline than females. Dorsal margin moderately convex in males, straighter but somewhat sinuous and about three-fifths of shell length in females. Ventral margin slightly convex in males, sinuous in females. Anterior margin broadly rounded, slightly extended below; posterior margin more narrowly rounded and extended medially in males, about equal in breadth to anterior and extended above in females. Left valve larger than right, overlapping and extending beyond the other along free margins; dorsally, right valve overlaps and extends beyond left. Valves strongly convex, thickest about one-third from posterior end; females slightly compressed anterior to position of greatest thickness. In some specimens, particularly in females, there is a very weak transverse dorsomedian furrow that is represented on interior surface by a slight ridge. Surface smooth except for widely scattered tiny pits that mark external openings of normal canals.

For a discussion of internal features, refer to the description of the genus.

Length of male paratype (U.S.N.M. 116641, pl. 1, fig. 22) 0.72 mm, height 0.47 mm, thickness 0.40 mm. Length of female holotype (U.S.N.M. 116642, pl. 1, fig. 9) 0.91 mm, height 0.56 mm, thickness 0.44 mm.

Relationships.—There are no known close relatives of this species in the Mesozoic, except *Aparchitocythere loeblichorum* (Swain and Peterson) from the Redwater member at its type locality and an undescribed species in the lower part of the Sundance. *A. loeblichorum* is much shorter and has the dorsal margin more convex than the present species. In the Miocene of the southeastern United States there are several species of *Basslerites* Howe that are similar to the new species in shape, but the hinge of *Basslerites* consists of strong knoblike teeth and sockets.

Occurrence.—(1) Upper part of the Sundance or Redwater shale member of the Sundance formation, Red Gulch, Sec. 22, T. 58 N., R. 89 W., Sheridan County, Wyoming; J–61d, f–h, 1–p. (2) Swift formation, southwest corner of Red Dome, Sec. 19, T. 7 S.,

R. 24 E., Carbon County, Montana; J–10b, c, 11c, d, 12a. (3) Swift formation, near Heath, Sec. 2, T. 14 N., R. 19 E. and Sec. 35, T. 15 N., R. 19 E., Fergus County, Montana; J–14a. (4) Swift formation, one mile southwest of Landusky, Sec. 32, T. 25 N., R. 24 E., Phillips County, Montana; J–22d. (5) Shoshone River gorge, 2 miles west of Cody, Wyoming; J–43b, c.

Aparchitocythere loeblichorum (Swain and Peterson)

Plate 1, figures 19, 20, 23–25

Apatocythere loeblichorum Swain and Peterson, 1951, Jour. Paleontology, vol. 25, p. 799, pl. 113, figs. 3–5.

Shell features that were not observed in the rather poorly preserved specimens on which the species was based are as follows:

Dimorphism in the species is represented by subovate specimens like the holotype, presumably males, and more elongated subquadrate specimens, presumably females.

The right valve overlaps and extends beyond the left along the hinge conspicuously in male dimorphs, less so in females. The right valve bears a hinge groove for reception of edge of left, and there are small terminal notches in the left valve hinge for reception of corresponding slight elevations in right.

The coarse weak surface pitting is supplemented in some specimens by a faint and much finer pitting.

Length of female shell (U.S.N.M. 116647, pl. 1, fig. 19) 0.44 mm, height 0.30 mm, thickness 0.22 mm. Length of a male shell (U.S.N.M. 116649, pl. 1, fig. 23) 0.38 mm, height 0.30 mm, thickness 0.20 mm.

Occurrence.—(1) Upper part of the Sundance or Redwater shale member of the Sundance formation, Red Gulch, Sec. 22, T. 58 N., R. 89 W., Sheridan County, Wyoming; J–61a. (2) One mile southwest of Landusky, Sec. 32, T. 25 N., R. 24 E., Phillips County, Montana; J–22d. (3) The species was originally described from 100–105 feet above base of the Redwater shale member of the Sundance formation at the type locality, Sec. 2, T. 7 N., R. 1 E., Butte County, South Dakota.

Genus MONOCERATINA Roth

Monoceratina sundancensis Swain and Peterson

Plate 2, figures 1–7

Monoceratina sundancensis Swain and Peterson, 1951, Jour. Paleontology, vol. 25, p. 803, pl. 114, figs. 7–15.

Shell features not given in the original description are: left valve extends beyond right along anterior dorsal slope, but right valve extends beyond left in mid-dorsal region as previously stated; in some specimens swollen ventral surface bears a low alaform ridge.

Length of a figured specimen (U.S.N.M. 116659, pl. 2, fig. 1) 0.36 mm, height 0.19 mm, thickness 0.18 mm.

Occurrence.—(1) Upper part of the Sundance or Redwater shale member of the Sundance formation, Red Gulch, Sec. 22, T. 58 N., R. 89 W., Sheridan County, Wyoming; J–61e–j. (2) Swift formation, Red Dome, Sec 19, T. 7 S., R. 24 E., Carbon County, Montana; J–11b,c,d. (3) Swift formation, near Heath, Sec. 2, T. 14 S., R. 19 E. and Sec. 35, T. 15 N., R. 19 E., Fergus County, Montana; J–14a. (4) Swift formation, one mile southwest of Piper, Sec. 17, T. 14 N., R. 20 E., Fergus County, Montana; J–19. (5) Swift formation, one mile southwest of Landusky, Sec. 32, T. 25 N., R. 24 E., Phillips County, Montana; J–22a, f, j. (6) The species was first described from 40 to 59 feet above base of Redwater shale member at its type locality, Sec. 2, T. 7 N., R. 1 E., Butte County, South Dakota.

Genus Camptocythere Triebel, 1950

Shell subovate in side view; dorsum moderately to strongly convex; ventrum less convex; ends rounded, posterior more pointed than anterior. Right valve strongly overlaps left dorsally, left valve overlaps right ventrally and terminally. Valves moderately convex, thickest medially. Surface smooth, pitted and in some species with short median subvertical furrows.

Hinge of right valve consists of terminal small elongate teeth, and intervening narrow bar dorsad of which is a broad accommodation groove; hinge of left valve consists of terminal weak sockets and intervening narrow groove. Muscle scar consists of a median subvertical row of four spots and two additional more anterior spots. Inner lamellae narrow, line of concrescence and inner margin nearly or actually coinciding. Radial canals simple and widely spaced (after Triebel, 1950).

Type Species.—*Camptocythere praecox* Triebel, 1950.

Geologic range and geographic Distribution.—Middle and upper Jurassic, Europe, North America.

Camptocythere elliptica Swain and Peterson, n. sp.

Plate 2, figures 8–13

Shell elongate-subelliptical in lateral view; hinge margin straight to slightly sinuous and half to two-thirds of shell length; ventral margin nearly straight and subparallel to dorsum; anterior margin broadly rounded, slightly extended below, truncate above; posterior margin more narrowly rounded, extended dorsomedially. Left valve larger than right, overlapping along free margins and extending beyond right terminally; dorsally, right valve overlaps and extends beyond left. Valves moderately convex, thickest postmedially and ventrally, ventral surface flattened.

A weak sulcus occurs in mid-dorsal region; in presumed female dimorphs valve markedly swollen posterior to sulcus resulting in a slight overhang along posterior half of dorsal and ventral margins. In some specimens, particularly in females, there is a low, rounded, slightly anteromedian node representing the position of the adductor muscle scar. Well-preserved specimens have surface of valves very finely pitted.

Hinge of right valve consists of terminal small toothlike elevations, of which the anterior is the higher, and an interterminal groove. Hinge of left valve correspondingly consists of terminal shallow sockets and an interterminal bar formed of the valve edge. Muscle scar a slightly anteromedian vertical row of four spots and an additional more anterior spot. Inner lamellae of moderate width, broadest anteriorly; line of concrescence and inner margin slightly separated. Radial canals few and widely spaced.

Length of holotype (U.S.N.M. 116666, probably a female) 0.49 mm, height 0.28 mm, thickness 0.23 mm.

Relationships.—The general shape, flattened ventrum and hingement ally this species with *Camptocythere* Triebel. *Aparchitocythere* Swain and Peterson, n. gen., is closely similar but lacks the flattened ventrum and ventral swelling of *Camptocythere*. *Monoceratina sundancensis* Swain and Peterson, and *Leptocythere imlayi* Swain and Peterson although more elongate and differing in other respects of shape are nevertheless like *Camptocythere* in hingement, flattened ventrum, dorsal overlap of right valve, and weak median sulcus. All of these forms appear to be ancestrally related, and the species we have referred to *Monoceratina* and *Leptocythere* may require assignment to new genera.

Occurrence.—Upper part of the Sundance or Redwater shale member of the Sundance formation, Red Gulch, Sec. 22, T. 58 N., R. 89 W., Sheridan County, Wyoming; J–61f-n.

Genus LEPTOCYTHERE Sars, 1925

Leptocythere imlayi Swain and Peterson

Plate 1, figures 26–30

Leptocythere imlayi Swain and Peterson, 1951, Jour. Paleontology, vol. 25, pp. 804–805, pl. 114, figs. 16–24.

Three immature molts and two adult shells of this species are illustrated to show the close relationship to *Monoceratina* Roth. In the molts the shell is much shorter, more pointed and more strongly extended posteriorly than in the adult. The posteroventral surface of the immature valve is swollen to form a slight overhang; the posterior end of the shell is compressed. The hinge of the right valve bears slight terminal elevations, but is otherwise smooth. The inner lamellae are narrow but distinctly developed.

Length of figured adult specimen (U.S.N.M. 116653, pl. 1, fig. 27) 0.51 mm, height 0.28 mm, thickness 0.19 mm. Length of an immature molt (U.S.N.M. 116654, pl. 1, fig. 28) 0.36 mm, height 0.24 mm, thickness 0.16 mm.

Occurrence.—(1) Upper part of the Sundance or Redwater shale member of the Sundance formation, Red Gulch, Sec. 22, T. 58 N., R. 89 W., Sheridan County, Wyoming; J–61h–n. (2) Swift formation, near Heath, Sec. 2, T. 14 N., R. 19 E. and Sec. 35, T. 15 N., R. 19 E., Fergus County, Montana; J–14a. (3) Swift formation, one mile southwest of Piper, Sec. 17, T. 14 N., R. 20 E., Fergus County, Montana; J–19. (4) Swift formation, one mile southwest of Landusky, Phillips County, Montana; J–22j.

Genus CYTHERURA Sars, 1866

Cytherura? lanceolata Swain and Peterson

Plate 1, figures 31–33

Cytherura? lanceolata Swain and Peterson, 1951, Jour. Paleontology, vol. 25, pp. 802–803, pl. 114, figs. 5, 6, 27, 28.

This species is characterized by subovate to subquadrate outline with well defined anterior cardinal angulation; ventral portion of anterior margin extended and bluntly acuminate, short posteroventral alae, and right valve overlapping along the hinge.

Length of a figured specimen (U.S.N.M. 116656, pl. 1, fig. 31) 0.39 mm, height 0.23 mm, thickness 0.16 mm.

Occurrence.—(1) Upper part of the Sundance or Redwater shale member of the Sundance formation, Red Gulch, Sec. 22, T. 58 N., R. 89 W., Sheridan County, Wyoming; J–61e, g, h, i, j, k, m. (2) Swift formation, Red Dome, Sec. 19, T. 7 S., R. 24 E., Carbon County, Montana; J–11c, d. (3) Swift formation, near Heath, Sec. 2, T. 14 N., R. 19 E. and Sec. 35, T. 15 N., R. 19 E., Fergus County, Montana, J–14a. (4) Swift formation, Sec. 32, T. 25 N., R. 24 E., Phillips County, Montana; J–22f. (5) The species was originally described from 40 to 63 feet above base of Redwater shale member at its type locality Sec. 2, T. 7 N., R. 1 E., Butte County, South Dakota.

Genus PROGONOCYTHERE Sylvester-Bradley, 1948

Progonocythere hieroglyphica Swain and Peterson

Plate 2, figures 18–20

Progonocythere hieroglyphica Swain and Peterson, 1951, Jour. Paleontology, vol. 25, pp. 800–802, pl. 113, figs. 10–18.

The outstanding shell characteristics of this species are: small size (about 0.6 mm long), subquadrate outline; left valve slightly the larger; surface ornamented by two or three outer concentric ridges, four or five postmedian ventral ridges, and several diversely arranged anteromedian ridges; a short oblique anteromedian sulcus; hinge of left valve consists of terminal elongate denticulate sockets and an interterminal weakly crenulate bar; that of right valve the antithesis; inner lamellae fairly broad.

Length of a figured specimen (U.S.N.M. 116677) 0.56 mm, height 0.27 mm, thickness 0.30 mm.

Occurrence.—(1) Sundance formation, Redwater shale member, Sec. 3, T. 6 N., R. 2 E., Lawrence County, South Dakota; J–47c, e–g. (2) Sundance formation, Redwater shale member, Sec 18, T. 45 N., R. 60 W., Weston County, Wyoming; J–52f. (3) Sundance formation, Redwater shale member, Sec. 14, T. 7 S., R. 3 E., Fall River County, South Dakota; J–56d. (4) Upper part of the Sundance or Redwater shale member, Red Gulch, Sec. 22, T. 58 N., R. 89 W., Sheridan County, Wyoming; J–61b. (5) Swift formation, Red Dome, Sec. 19, T. 7 S., R. 24 E., Carbon County, Montana; J–10a. (6) Swift formation, one mile southwest of Piper, Sec. 17, T. 14 N., R. 20 E., Fergus County, Montana; J–19. (7) Swift formation, one mile southwest of Landusky, Sec. 32, T. 25 N., R. 24 E., Phillips County, Montana; J–22b, c, d, f, g. (8) Swift formation Shoshone River Gorge, 2 miles west of Cody, Wyoming; J–43b. (9) The species was originally described from 33–73 feet above base of Redwater shale member of Sundance formation at its type locality in Sec. 2, T. 7 N., R. 1 E., Butte County, South Dakota.

Progonocythere crowcreekensis Swain and Peterson

Plate 2, figures 22–25

Progonocythere crowcreekensis Swain and Peterson, 1951, Jour. Paleontology, vol. 25, p. 802, pl. 114, figs. 1–4.

This species is characterized by subquadrate outline, coarsely reticulate and pustulose surface, prominent anteromedian tubercle, and anteroventral marginal spines. It is about one-third larger than *P. hieroglyphica* Swain and Peterson.

Length of a figured female shell (U.S.N.M. 116681, pl. 2, fig. 23) 1.07 mm, height 0.52 mm, thickness 0.56 mm; length of a figured male (U.S.N.M. 116680, pl. 2, fig. 22) 0.85 mm, height 0.45 mm, thickness 0.46 mm.

Occurrence.—(1) Sundance formation, Redwater shale member, Sec. 3, T. 6 N., R. 2 E., Lawrence County, South Dakota; J–47f. (2) Sundance formation, Redwater shale member, Sec. 18, T. 45 N., R. 60 W., Weston County, Wyoming; J–52e, f. (3) Upper part of the Sundance or Redwater shale member, Red Gulch, Sec. 22, T. 58 N., R. 89 W., Sheridan County, Wyoming; J–61b–d. (4) Swift formation, Red Dome, Sec. 19, T. 7 S., R. 24 E., Carbon County, Montana; J–10a–c. (5) Swift formation, Sec. 17, T. 14 N., R. 20 E., Fergus County, Montana; J–19. (6) Swift formation, Sec. 32, T. 25 N., R. 24 E., Phillips County, Montana; J–22b, h. (7) Swift formation, Shoshone River Gorge, 2 miles west of Cody, Wyoming; J–43b. (8) The species was described from 40 to 59 feet above base of Redwater shale member at its type locality Sec. 2, T. 7 N., R. 1 E., Butte County, South Dakota.

Genus PROTOCYTHERE Triebel, 1938

Protocythere quadricarinata Swain and Peterson, n. sp.

Plate 2, figures 14–17, 21

Shell sublanceolate in side view; highest about one-fourth from anterior end; hinge margin nearly straight, about two-thirds of shell length, ventral margin slightly convex, converging posteriorly toward dorsum; anterior margin rounded, extended below; posterior margin more pointed, strongly extended medially. Left valve larger than right, extending beyond the other around entire periphery, but most strongly along ventrum and along dorsal slopes. Convexity of valves moderate, greatest thickness posteromedian; middle of each valve flattened in some specimens. Ends of each valve slightly compressed but more so in right valve than in left; left valve with terminal low marginal rims.

Middle two-thirds of each valve bears four longitudinal low ridges or swellings; dorsal ridge highest medially, narrow behind and broader in front; two median ridges merging anterior to midlength; ventral ridge barely differentiated from general surface of valve below. General surface bears a few scattered pits.

Hinge of left valve consists of an anterior, elongate, crenulate socket, a posterior shorter crenulate socket, and an interterminal bar the ventral slope of which bears an obscurely crenulate weak incision; dorsad of bar is an accommodation shelf. Hinge of right valve consists of terminal elongate, crenulate teeth; intervening hinge edge recessed and in the present material only obscurely crenulate. Inner lamellae of moderate width; line of concrescence and inner margin coincide) Muscle scar not observed.

Length of holotype (U.S.N.M. 116672), 0.65 mm, height 0.32 mm, thickness 0.31 mm.

Relationships.—The general shape, overlap, hingement and longitudinal ridges of this form conform to *Protocythere* Triebel. The double median ridge distinguishes it from other described species.

Occurrence.—(1) Upper part of the Sundance or Redwater shale member of the Sundance formation, Red Gulch, Sec. 22, T. 58 N., R. 89 W., Sheridan County, Wyoming; J–61c, d. (2) Swift formation, Red Dome, Sec. 19, T. 7 S., R. 24 E., Carbon County, Montana; J–10b, c. (3) Swift formation, Sec. 32, T. 25 N., R. 24 E., Phillips County, Montana; J–22f, g.

Genus CYTHEREIS Jones, 1849

Cythereis? zygoventralis Swain and Peterson, n. sp.

Plate 2, figures 26–32

Shell subquadrate in side view; highest about one-fifth from anterior end; hinge margin nearly straight, about two-thirds of shell length, and with rather well defined cardinal angles of which the anterior is the more obtuse; ventral margin nearly straight to gently convex, converging slightly with dorsum posteriorly; anterior margin broadly rounded, extended below, truncate above; posterior margin narrower, subtruncate. Left valve slightly larger than right, overlapping slightly along ventrum and extending beyond the other anterodorsally and posteriorly. Valves moderately convex, thick in ventral half, especially thick in posteroventral region.

Surface strongly and coarsely reticulate; dorsal and terminal margins bear narrow knife-edge rims; three prominent, longitudinal, narrow ridges in middle part of each valve: one above and two below midshell. The more ventral ridge typically strongly elevated near its posterior end and, in side view, overhanging ventral margin. Between the two ventral ridges and anterad of midlength is a short fourth ridge. Ends of ridges connected except posterior ends of dorsal and ventral ridges. Mid-dorsally are two or three short ridgelike elevations; anterodorsally, a short spur projects ventrally from marginal rim; a shallow sulcus lies behind this spur.

Hinge of right valve consists of an anterior elliptical tooth that bears a weak transverse groove, an interterminal groove, broadest anteriorly and very narrow medially, and a posterior rounded tooth. Hinge of left valve is composed of an anterior socket, an interterminal ridge, and a posterior socket. Muscle scar consists of a slightly anteromedian subvertical row of four tiny, closely spaced spots and a more anterior spot. Inner lamellae of moderate width with smooth inner margin. The latter and the line of concresence are slightly separated.

Dimorphism in the species is represented by larger, more subquadrate specimens that are presumably females.

Length of male holotype (U.S.N.M. 116685) 0.82 mm, height 0.45 mm, thickness 0.35 mm. Length of female paratype (U.S.N.M. 116687), 0.89 mm, height 0.44 mm, thickness 0.35 mm.

Relationships.—Several ostracodes that are illustrated but not formally described or named by Brand (1949, pls. XI–XIV) as "ostracode 72, ostracode 88b, and ostracode 89a,b" from the upper part of the Middle Jurassic (Dogger) of northwestern Germany resemble *C.? zygoventralis* but Brand's illustrations are not clear enough to permit detailed comparisons.

The species lacks the crenulate hinge, median node, and except in immature molts the posterior strongly elevated points, features typical of *Cythereis*, but seems closer to that genus than to any other. There is a slight tendency for the posterior end to be compressed and the adjacent surface to have its ornamental ridges a little more strongly elevated there than elsewhere, features that are reminiscent of *Cythereis*. For the time being the new species will be referred to *Cythereis*, although probably the discovery of related species will require establishment of a new genus.

Specimens show a great deal of variation, especially in surface ornamentation. In some specimens the reticulations are very weak and the longitudinal ridges provide almost the only ornamentation; in other specimens the reticulations are deeply developed and nearly obscure the longitudinal ridges. The strongly elevated ventral ridges in the presumed male dimorphs provide a subalate appearance, and result in a flattened aspect of the ventrum; the female dimorphs lack this feature.

Immature molts of the species are rare in the present collection except in samples from locality J–61j. The surfaces of these immature molts are finely pitted, the reticulations are developed only in patches and the longitudinal ridges are very delicate but fairly well defined; the ridge along the dorsum and the two ventral ridges terminate posteriorly in prominent elevations in several of the molts, and there is a terminal point on the submedian ridge of some molts. The ventral ridges in the earlier molts form short but conspicuous alae, and the posterior end of the shell is distinctly compressed.

Occurrence.—Upper part of the Sundance or Redwater shale member of the Sundance formation, Red Gulch, Sec. 22, T. 58 N., R. 89 W., Sheridan County, Wyoming; J–61g–l.

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PLATE 1

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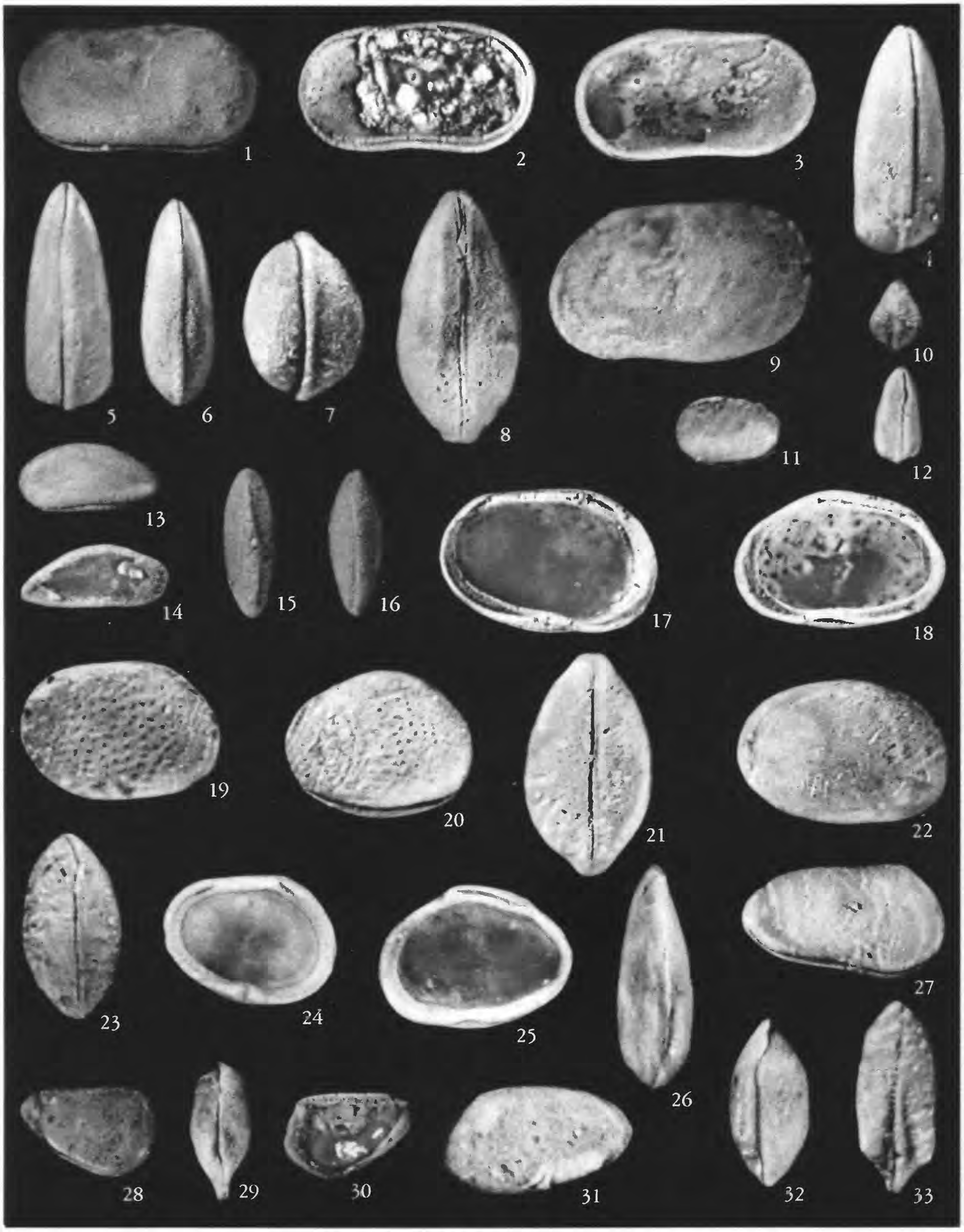
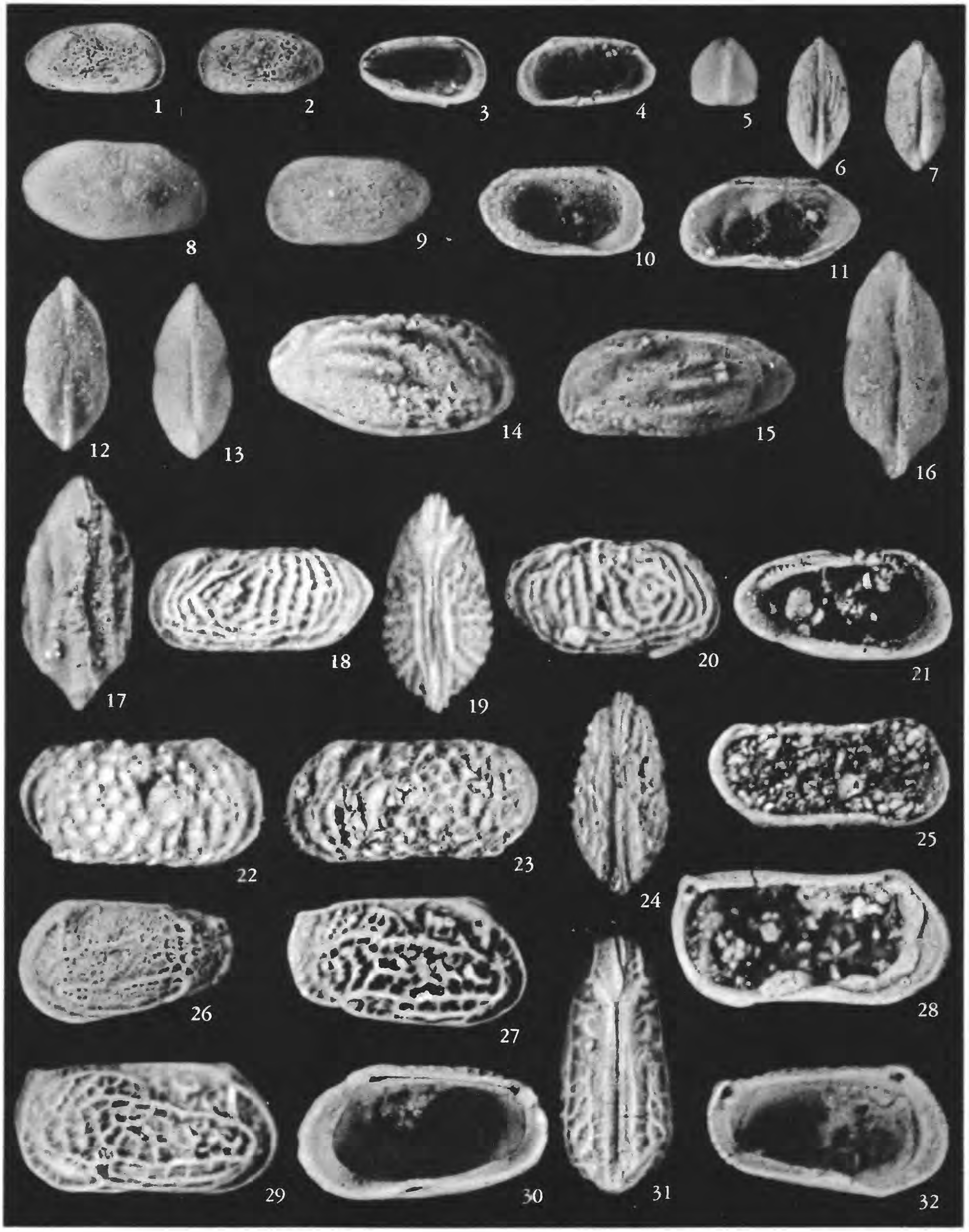


CYTHERELLIDAE, CYPRIDAE AND CYTHERIDAE



CYTHERIDAE

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