OSTRACODA OF THE LIMESTONES OF THE PERMIAN SYSTEM WOLFCAMP SERIES IN KANSAS

by

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INTRODUCTION

Purpose of the Investigation

This investigation of the ostracode microfauna of the limestones of the Wolfcamp series in Kansas was undertaken to obtain data on the abundance, and the stratigraphic and paleoecological distribution of the ostracodes. Previous studies of microfaunas have been devoted almost exclusively to beds of shale with only scattered sampling of the limestones; therefore, it was felt that an investigation of this nature would add to our knowledge of the micropaleontology of ostracodes.

The sparsity of information on techniques of sampling and preparing limestones for micropaleontological examination were other factors which posed a problem. It was fully realized that this problem would necessitate various trial and error methods both in the field and laboratory before a satisfactory technique could be developed.

Although the main emphasis of the study was to be given to the ostracodes of the limestones, other microfossils were not to be disregarded; on the contrary, they might yield valuable stratigraphic information. The forms, other than ostracodes, considered to be most valuable stratigraphically were the foraminifers and the conodonts.

Area Covered by this Investigation

The area covered by this investigation included seven counties (Fig. 1) in the eastern half of Kansas. The counties from which the samples were collected are: Geary, in the third tier

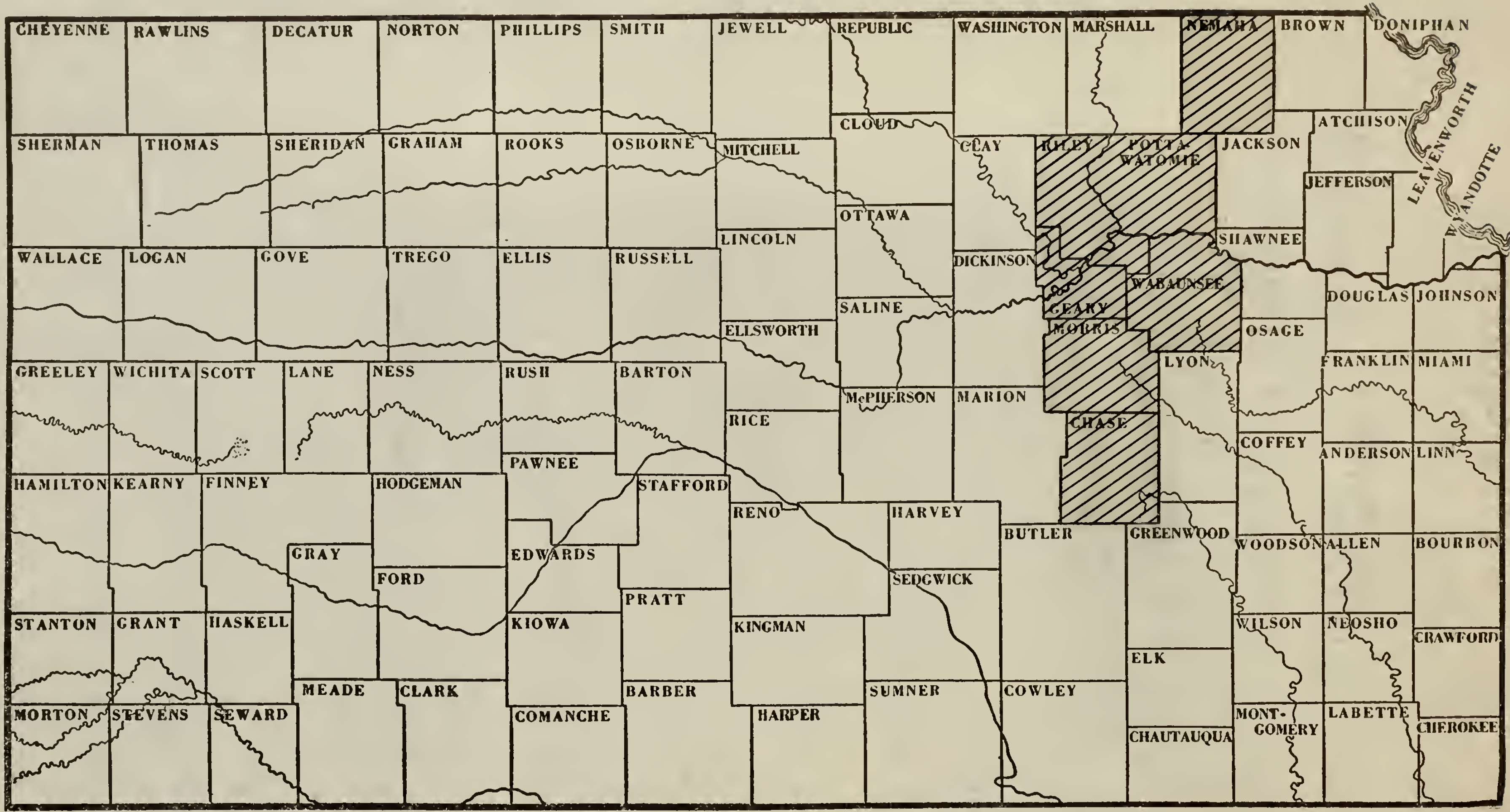


Fig. 1. Area covered by this investigation.

of counties south of the Nebraska border and in the fifth tier west of the Missouri border; Pottawatomie, in the second tier of counties south of the Nebraska border and in the fourth tier west of the Missouri border; Morris, in the fourth tier of counties south of the Nebraska border and in the fifth tier west of the Missouri border; Chase, in the third tier of counties north of the Oklahoma border and in the fourth tier west of the Missouri border; Wabaunsee, in the third tier of counties south of the Nebraska border and in the third tier west of the Missouri border; Nemaha, in the first tier of counties south of the Nebraska and in the third tier west of the Missouri border; and Riley, in the second tier of counties south of the Nebraska border and in the fifth tier of counties west of the Missouri border.

Although samples were taken from the seven counties, most of them were collected in Riley County. The accessibility and greater number of measured stratigraphic sections were the principal reasons for procuring most of the samples from this county.

Stratigraphy

The samples for this investigation were taken from the Wolfcamp series (Fig. 2) which contains the oldest rocks of Permian age in Kansas. This series consists of three groups of formations which, in general, are composed of interbedded limestones and shales.

The Admire group, the lowermost unit of the Wolfcamp series, consists predominantly of nonfossiliferous clastic sediments in the lower part grading upward into thin beds of fossiliferous limestone and shale.

The Council Grove group is the medial group in the Wolfcamp series and is composed of moderately thick beds of limestone which alternate with vari-colored shales. This group is the most fossiliferous of the three. It contains practically all known ostracode genera present in the underlying Admire group and the overlying Chase group. Although fossils are very numerous in many zones in this group, there are some zones that are known to be entirely nonfossiliferous.

The Chase group, the uppermost group of the Wolfcamp series, consists of relatively thick beds of limestone separated by bright vari-colored shales. Many of the limestones in this group are characterized by bands of blue-gray chert. This group is generally less fossiliferous than the underlying Council Grove group, but very fossiliferous zones do occur in the Barneston and Wreford limestones.

Register of Stratigraphic Zones and Collecting Localities. In this register, the sample number is given first and is followed by the stratigraphic zone and geographic locality:

1. Aspinwall limestone, SE$\frac{1}{4}$ NE$\frac{1}{4}$ sec. 9, T. 11 S., R. 9 E.
2. Aspinwall limestone, NE$\frac{1}{4}$ NW$\frac{1}{4}$ sec. 36, T. 10 S., R. 9 E.
3. Aspinwall limestone, sec. 18, T. 1 S., R. 11 E.
4. Falls City limestone, NW$\frac{1}{4}$ SE$\frac{1}{4}$ sec. 8, T. 13 S., R. 13 E.
5. Falls City limestone, SE$\frac{1}{4}$ SE$\frac{1}{4}$ SE$\frac{1}{4}$ sec. 25, T. 6 S., R. 11 E., road cut.
6. Falls City limestone, NW$\frac{1}{4}$ SW$\frac{1}{4}$ sec. 8, T. 11 S., R. 9 E., road cut.
7. Falls City limestone, NE$\frac{1}{4}$ SW$\frac{1}{4}$ sec. 12, T. 11 S., R. 8 E., road cut.
8. Five Point limestone, NW$\frac{1}{4}$ SW$\frac{1}{4}$ sec. 30, T. 10 S., R. 9 E., old quarry.

9. Five Point limestone, SE¼ SW¼ NW¼ sec. 20, T. 9 S., R. 11 E., road cut.
10. Five Point limestone, SW¼ NW¼ sec. 8, T. 11 S., R. 9 E., ditch along road.
11. Five Point limestone, SE¼ SE¼ sec. 12, T. 11 S., R. 8 E., road cut.

Hamlin shale.

12. Houchen Creek limestone member, NW¼ NW¼ sec. 31, T. 11 S., R. 12 E., road cut.

Foraker limestone

13. Americus limestone member, Bluemont Hill, northeast side of Manhattan, Kansas, sec. 7, T. 10 S., R. 8 E., railroad cut.
14. Americus limestone member, NW¼ SW¼ sec. 30, T. 10 S., R. 9 E., hillside above abandoned quarry.
15. Americus limestone member, NE¼ SE¼ sec. 36, T. 10 S., R. 9 E., stream cut.
16. Long Creek limestone member (uppermost and lowermost foot) NE¼ SE¼ sec. 7, T. 10 S., R. 8 E., road cut.
17. Long Creek limestone member, NW¼ SE¼ sec. 36, T. 10 S., R. 9 E., stream cut.

Red Eagle limestone

18. Glenrock limestone member, NE¼ SE¼ sec. 7, T. 10 S., R. 8 E., road cut.
19. Glenrock limestone member, SE¼ sec. 3, T. 1 S., R. 13 E., road cut.
20. Howe limestone member, CN½ sec. 26, T. 10 S., R. 7 E., road cut.
21. Howe limestone member, NE¼ SE¼ sec. 7, T. 10 S., R. 8 E., road cut.
22. Howe limestone member, SW¼ NW¼ NW¼ sec. 12, T. 15 S., R. 12 E.
23. Howe limestone member (middle thick portion), NE¼ NW¼ sec. 1., T. 1 S., R. 14 E., creek cut.

Grenola limestone

24. Burr limestone member (uppermost and lowermost foot) CN½ sec. 26, T. 10 S., R. 7 E., road cut.
25. Burr limestone member (lowermost foot), SW¼ SW¼ SW¼ sec. 21, T. 9 S., R. 8 E., road cut.
26. Burr limestone member (upperpart), SW¼ SE¼ sec. 23, T. 10 S., R. 7 E., road cut.
27. Neva limestone member (uppermost and lowermost foot), CN½ sec. 26, T. 10 S., R. 7 E., road cut.
28. Neva limestone member (lower part), NE¼ NE¼ sec. 32, T. 10 S., R. 8 E., road cut.
29. Neva limestone member (upper part), SW¼ SE¼ sec. 10, T. 10 S., R. 7 E., road cut.
30. Neva limestone member (uppermost foot), NE¼ NE¼ sec. 7, T. 11 S., R. 8 E., road cut.

Beattie limestone

31. Cottonwood limestone member (uppermost and lowermost foot), NE¼ SE¼ sec. 14, T. 9 S., R. 7 E., road cut.
32. Cottonwood limestone member (uppermost and lowermost foot), SE¼ NE¼ sec. 9, T. 11 S., R. 7 E., road cut.

33. Cottonwood limestone member (lowermost foot), CN½ sec. 26, T. 10 S., R. 7 E., road cut.
34. Morrill limestone member, NE¼ NW¼ sec. 34, T. 10 S., R. 8 E., road cut.
35. Morrill limestone member, NE¼ SE¼ sec. 14, T. 9 S., R. 7 E., road cut.
36. Morrill limestone member, SW¼ sec. 10, T. 9 S., R. 7 E., in old quarry.

Bader limestone

37. Eiss limestone member, SW¼ SE¼ sec. 28, T. 10 S., R. 8 E., road cut.
38. Eiss limestone member (uppermost and lowermost foot), NW¼ sec. 32, T. 10 S., R. 8 E., road cut.
39. Middleburg limestone member (lower part), C Sec. line sec. 28, T. 10 S., R. 8 E., road cut.
40. Middleburg limestone member, NE¼ NE¼ sec. 7, T. 11 S., R. 8 E., road cut.
41. Crouse limestone (massive portion), C Sec. line Sec. 28, T. 10 S., R. 8 E., road cut.
42. Crouse limestone (uppermost foot), NW¼ SE¼ sec. 29, T. 8 S., R. 7 E., road cut.
43. Crouse limestone, NE¼ NE¼ sec. 7, T. 11 S., R. 8 E., road cut.
44. Funston limestone (uppermost and lowermost foot) NW¼ NW¼ sec. 33, T. 10 S., R. 8 E., road cut.
45. Funston limestone (massive portion), SW¼ NE¼ sec. 13, T. 18 S., R. 9 E., road cut.
46. Speiser shale, (persistent limestone near top), NW¼ NW¼ sec. 33, T. 10 S., R. 8 E., road cut.
47. Speiser shale (persistent limestone near top), C sec. 29, T. 8 S., R. 9 E., road cut.
48. Speiser shale (persistent limestone near top), SW¼ SW¼ sec. 30, T. 9 S., R. 7 E., road cut.
49. Speiser shale (persistent limestone near top), SE¼ SE¼ sec. 31, T. 6 S., R. 7 E., road cut.

Wreford limestone

50. Threemile limestone member (uppermost and lowermost foot), C sec. 29, T. 8 S., R. 7 E., road cut.
51. Threemile limestone member, SW¼ NW¼ sec. 33, T. 10 S., R. 8 E., road cut.
52. Threemile limestone member (lowermost foot), SW¼ SW¼ sec. 30, T. 9 S., R. 7 E., road cut.
53. Threemile limestone member (uppermost foot), SW¼ NW¼ sec. 21, T. 11 S., R. 8 E., road cut.
54. Schroyer limestone member, C sec. 29, T. 8 S., R. 9 E., road cut.
55. Schroyer limestone member (uppermost foot), C SW¼ sec. 23, T. 15 S., R. 8 E., road cut.
56. Schroyer limestone member (uppermost foot) NE¼ SW¼ sec. 29, T. 8 S., R. 7 E., road cut.
57. Schroyer limestone member (uppermost foot), NW¼ NW¼ sec. 21, T. 11 S., R. 8 E., road cut.

Matfield shale

58. Kinney limestone member (uppermost and lowermost foot), SE¼ NE¼ sec. 2, T. 7 S., R. 6 E., road cut.

59. Kinney limestone member (uppermost foot), sec. 18, T. 22 S., R. 7 E., road cut.
60. Kinney limestone member (uppermost foot), NE¼ NW¼ sec. 29, T. 8 S., R. 7 E., road cut.
61. Kinney limestone member (lowermost foot), NE¼ SW¼ sec. 10, T. 6 S., R. 7 E., road cut.
62. Kinney limestone member (uppermost and lowermost foot), SW¼ SW¼ sec. 21, T. 11 S., R. 8 E., road cut.

Barneston limestone

63. Florence limestone member (uppermost foot), C. sec. 29, T. 8 S., R. 9 E., road cut.
64. Florence limestone member (lowermost foot), NW¼ NW¼ sec. 28, T. 11 S., R. 8 E., road cut.
65. Florence limestone member (upperportion just above shale parting 3 ft. from top), SE¼ NW¼ sec. 24, T. 9 S., R. 6 E., road cut.
66. Fort Riley limestone member (uppermost foot), C sec. 29, T. 8 S., R. 7 E., quarry.
67. Fort Riley limestone member (lowermost foot), SE¼ NW¼ sec. 33, T. 5 S., R. 7 E., road cut.
68. Fort Riley limestone member (uppermost foot of rimrock), across from cemetery on highway 40, Fort Riley Military Reservation.

Doyle shale

69. Towanda limestone member (lowermost foot), NE¼ NW¼ sec. 13, T. 6 S., R. 6 E., road cut.
70. Towanda limestone member (uppermost foot), SE¼ SE¼ sec. 21, T. 8 S., R. 6 E., road cut.
71. Towanda limestone member (lowermost foot), SE¼ SE¼ sec. 24, T. 8 S., R. 6 E., road cut.
72. Towanda limestone member (lowermost foot), SE¼ SW¼ SW¼ sec. 17, T. 7 S., R. 6 E., road cut.

Winfield limestone

73. Stovall limestone member (lowermost foot), NE¼ SE¼ sec. 36, T. 7 S., R. 5 E., road cut.
74. Stovall limestone member (lowermost foot), SE¼ SE¼ sec. 17, T. 7 S., R. 6 E., road cut.
75. Cresswell limestone member (uppermost and lowermost foot), NE¼ NE¼ sec. 1, T. 8 S., R. 5 E., road cut.
76. Cresswell limestone member, (middle part just above massive limestone), center of west sec. line sec. 19, T. 7 S., R. 6 E., road cut.
77. Cresswell limestone member (lowermost foot), NE¼ NE¼ sec. 20, T. 7 S., R. 6 E., road cut.

Nolans limestone

78. Krider limestone member, NE¼ SE¼ sec. 1, T. 8 S., R. 5 E., creek cut.
79. Krider limestone member, SW¼ NW¼ sec. 23, T. 8 S., R. 4 E., road cut.
80. Herington limestone member (uppermost and lowermost foot), NE¼ NE¼ sec. 1, T. 8 S., R. 5 E., road cut.
81. Herington limestone member (lower 2 feet), NE¼ NW¼ sec. 32, T. 7 S., R. 5 E., road cut.
82. Herington limestone member (upper 2 feet), NW¼ SW¼ sec. 15, T. 6 S., R. 6 E., road cut.

Field Methods

As a preliminary to this investigation, it wasnecessary to become thoroughly familiar with the stratigraphy of the Wolfcamp series, consequently much time was spent in field familiarization before the actual sampling was begun. Previously measured sections prepared by the staff of the U. S. Geological Survey field office at Kansas State College proved invaluable for this preliminary study. The use of these sections provided this worker data which insured correct orientation while becoming familiar with the local stratigraphic section.

The samples used in this investigation were all collected from surface outcrops so that their stratigraphic zonation would be exact. No float-rock samples were collected and every care was taken to guard against contamination of the samples.

To insure complete coverage at each outcrop, the sample was collected along the entire outcrop, thus avoiding the possibility of sampling a narrow barren zone which would not reveal the true faunal assemblage. The average linear distance covered was about fifty yards.

To facilitate better coverage vertically the upper and lowermost foot was sampled if the limestone under consideration was thick enough to warrant such a procedure. By taking samples in this manner, it is believed that a better fauna can be obtained and that the possibility of a faunal change between the upper and lower zones can be more readily recognized.

The amount of field sample varied somewhat but usually about four pounds of rock was collected. This amount of material gave an adequate quantity for preparing the samples in various ways, and also left a sufficient amount in the event subsequent re-working of the sample proved necessary.

Each sample was placed in a cloth or paper bag, which was labeled as to stratigraphic unit, zone within the unit (upper or lower), and geographic location. The location for each sample included, where possible, the quarter quarter section, township, and range. A duplicate label was also placed inside the bag to insure against loss of data.

Laboratory Methods

In the preparation of the samples for scanning under a binocular microscope, various methods were used to disintegrate the limestone. The freeze-and-thaw method was the first tried. The equipment used consisted of an ordinary home refrigerator, small freezing trays, and glass beakers to hold the limestone sample until it could be completely saturated with water. After letting the sample stand in water for three days to permit full saturation, it was removed from the water and placed in the freezing trays which contained a small quantity of water to prevent desaturation while the sample was freezing. After the sample was frozen, it was removed from the refrigerator and boiling water poured over it to facilitate a rapid thaw. Once the sample was completely thawed it was returned to the freezing compartment. This process was repeated until the limestone was disintegrated sufficiently to free the microfossils from the limestone matrix. The number of cycles necessary varied for different lithologies but the average was twenty-three.

The specimens recovered in this manner were excellent, with very little destruction of the diagnostic characteristics necessary to the specific identification of the ostracodes. Although the specimens recovered were of high quality, the number of cycles necessary for disintegrating the limestone lessens the value of this method where preparation of many samples are necessary because of the long time required.

Another procedure used in disintegrating limestone is the growing-crystal method. The limestone was broken into small pieces and placed in a super-saturated solution of sodium sulphate. The mixture of sodium sulphate and limestone fragments was boiled for fifteen minutes. After boiling was completed, the mixture was placed in a vacuum jar from which all the air was removed so that better impregnation of the limestone by the sodium-sulphate solution would result. The mixture was removed from the vacuum jar to crystallize as it cooled.

This process was repeated ten times before the limestone disintegrated enough to release the microfossils. The mixture was then washed with a one percent solution of HCl and then immediately washed with water to remove the sodium-sulphate and acid.

Although a few good specimens were recovered by this method it was abandoned because the amount of time required made it impossible to recover enough specimens for this investigation.

The third method used for disintegrating the limestones required the use of an electric oven which was allowed to heat to a temperature of 250° F. The sample was placed in the oven and left there for fifteen minutes to permit heating. The sample was then removed from the oven and immersed in cold water to cause rapid cooling. This process was repeated until the limestone was disintegrated.

The microfossils recovered were badly broken and calcined and specific identifications were found to be impossible.

Some of the limestones were treated with hydrochloric acid to determine if silicified ostracodes and other microfossils were present. The procedure used for preparing the samples was the same as used for most insoluble-residue studies. The only exceptions were acid treatment and handling.

The sample was treated with a twenty percent solution of acid instead of the customary concentrated solution used for insoluble-residue studies. The basis for using the less concentrated solution was to hold agitation to a minimum. The additional acid necessary was added in small quantities and poured slowly for the same reason. Under no circumstance was the prearation stirred; agitation would destroy some of the delicate structures that might be present after the matrix was removed. Insoluble-residue material from the Falls City limestone contains an abundance of micro-brachiopods which possess many long slender spines. The spines were almost obliterated if the solution was stirred or agitated in any other manner. However, if care was taken in processing the sample, the spines were very well preserved.

The only silicified ostracodes found were in the Falls City limestone which contains a sparse microfauna.

The last method tried, and by far the most successful of them, was the one usually used for preparing shale samples for examination.

Each limestone sample was broken into small fragments which were crushed individually in a mortar or on a rubber cushion (piece of an inner tube). The inner tube was discarded because it was found that the samples crushed with the mortar and pestle were equally as good and required less time. To avoid pulverizing the specimens, the fragments were crushed individually in the mortar instead of in large quantities, which is the practice in preparing shale samples. In crushing the limestone, it was found that if the fragment was struck only one hard vertical blow the ostracodes released were much cleaner and free of cracks and chipped margins. If the fragment only partially disintegrated by one blow the larger parts were removed and used again. This procedure required more time than required in normal crushing methods but the specimens recovered were superior.

The crushed material was poured into a glass beaker, washed and decanted until all the clay-size particles were removed.

Some workers have suggested letting the crushed material soak in some deflocculating solution (usually sodium hydroxide) from one to three hours before boiling. However, this was found to bea poor practice because the specimensbecame etched and coated with the base used.

After the crushed sample was washed and decanted it was boiled for twenty minutes in a ten percent solution of sodium hydroxide. Some samples were deflocculated with potassium hydroxide or sodium silicate but after preparing several samples it was determined that the sodium hydroxide proved to be a better defloculating agent.

The sample, after boiling, was again washed and decanted to remove any material released by the boiling action. Care was taken to wash the sample clean to prevent coating by the sodium hydroxide. The sample was then placed on a paper and dried at room temperature.

The sample was screened after drying to grade the samples into various sizes to facilitate ease of scanning. U. S. Standard screens Nos. 10, 18, 40 and 100 were used. All of the material that passed through the No. 100 screen was discarded because of the small size of the particles. The material collected on the No. 10 screen was scanned rapidly to see if any large specimens were present; if not, it was also discarded. The material collected on the other screens was placed in individual bottles and labeled with the sample number.

Examination of the Screened Sample. The equipment used for scanning the samples consisted of a binocular microscope, a black tray ruled with white guide lines, slides for storage of the specimens picked, and a No. 00 sable-hair brush for picking.

The amount of sample to be picked from each stratigraphic unit was arbitrarily set at 30 grams. The sample was spread over the bottom of the tray and the specimens were removed from the tray with the brush and placed in storage slides.

Identification of the Ostracodes

The identification of the ostracodes presented in this investigation is based on the original description of the species and as many synonomies as possible. The literature on many of the old well-established species is voluminous; therefore it was impossible to examine all but a sincere effort was made to examine a sufficient number to gain an adequate understanding of the species.

The characteristics considered most important in identification of the ostracode species of the Wolfcamp series are:

1. The general outline of the margin when viewed laterally.

2. The position of greatest height and thickness.

3. The character of the hinge line, especially in regard to angulation, depression, elevation, and relative length.

4. Outline as seen in dorsal, ventral, and end view.

5. Overlap or relative size of valves, which in most cases is considered to be of generic rather than specific value.

6. Surface features such as nodes, spines, sulci, flanges, etc.

7. Measurements, including length, height, thickness, and length-to-height-ratio.

Depository. The figured specimens and the three new species proposed have been deposited in the Paleontological Collections of the Department of Geology, Kansas State College.

Orientation of the Carapace. The decision as to the proper orientation of fossil ostracodes is of the utmost importance because their identification depends entirely upon the selection of the anterior and posterior extremities. Various proposals have been fostered in attempts to establish criteria which could be used in the orientation of the fossil ostracodes, but at the present time no all-inclusive method of orientation has been universally adopted. The most widely used plan for the orientation of ostracodes in this country is the one proposed by Ulrich and Bassler (45). They gave the following criteria for the orientation of the Beyrichiacea which was later applied to all fossil Ostracoda:

> (1) the relative width, position and direction of the median furrow or sulcus which was found to be wider than either the anterior or the posterior sulcus, to lie almost always more or less behind the mid-length of the valves, and which when prolonged ventrally was found to curve more or less backward; (2) the correlation and identification of the median and posterior lobes, both of which lie behind the median sulcus and usually are distinctly separated by the posterior sulcus though occasionally completely confluent, as in Ctenobolbina ciliata: (3) the outline of the valves, particularly in straight-hinged forms, which commonly are more or less oblique and widest behind, with a backward swing from the hinge; an outline which suggests a parallelogram rather than an oblong figure; (4) the location of the brood pouch, which obviously should be associated with the posterior half of the carapace and which is fact always lies for the most part behind the anterior lobe.

The statement about the size of the median sulcus is undoubtedly true; but the position depends entirely upon a previously made selection of the anterior or posterior extremity, which also is the case in the second and third statements. The fourth statement, which does not apply to ostracodes found in the rocks covered by this investigation, is probably correct in most cases.

The orientation proposed for the Beyrichiacea by Ulrich and Bassler is followed in this investigation, although it is recognized that their proposals were somewhat erroneous. If another plan of orientation was used it would require redescription of all the forms falling in this group which, in my opinion, would contribut little of real value and would only add to an already perplexing problem.

The orientation used in many recent investigations is to designate the more inflated or blunt end as the posterior and the thin-pointed end as the anterior. This orientation is based on the characteristics found in the contemporaneous ostracodes. Although this idea was fostered by Jones and others about one hundred years ago it has only recently been followed by workers in this country. This method of orientation was the one used by this worker where applicable.

SYSTEMATIC DESCRIPTIONS OF THE OSTRACODE MICROFAUNA

The section here presented as Figures sets forth the systematic description of the ostracode microfauna that was recovered from the Permian limestones of the Wolfcamp series in the Eastern half of Kansas. The systematic descriptions list the major and minor taxonomic divisions; synonomy; original description where applicable; emended description if the original is inadequate; discussion of each species under consideration; and occurrence of the species. The occurrence of species is given in tabular form in another portion of this paper.

Fig. 2. Major taxonomic divisions.

Phylum ARTHROPODA

Class CRUSTACEA

Order OSTRACODA Latreille, 1806

Superfamily LEPERDITACEA Bassler and Kellett, 1934

Fig. 3. Genera and species of the family leperditellidae.

Family LEPERDITELLIDAE Ulrich and Bassler, 1906

Genus Paraparchites Ulrich and Bassler, 1906

Paraparchites Ulrich and Bassler, 1906, Proc. U. S. Nat. Mus., vol. 30, p. 149-150.

Original description: Carapace small, 1 mm to 2 mm in length, leperditoid or subovate in shape; surface smooth, sometimes with a small tubercle or spine in anter-cardinal third of each valve; right valve with ventral edge rabbeted so as to slightly overlap the simply beveled edge of the left valve; dorsal edge of valves usually unequal, the left slightly the more prominent and commonly overlapping the right or receiving its edge in a shallow groove.

Genotype by original designation: Paraparchites humerosus Ulrich and Bassler.

Paraparchites humerosus Ulrich and Bassler

Plate I, Fig. 1-3.

Paraparchites humerosus Ulrich and Bassler, 1906, U. S. Nat. Mus., Proc., vol. 30, p. 151, pl. 11, figs. 1-4; Wreford formation, Kansas. -Grabau and Skinner, 1910, North American Index Fossils, p. 344, text fig. 1657, g-i. -Delo, 1931, Wash. Univ. Studies, N. S., Sci. and Techn., no. 5, p. 42,

Fig. 3. cont.

pl. 4, fig. 1. -Kellett, 1933, Jour. Paleo., 7, no. 1, p. 64, pl. 13, figs. 1-12; Elmdale to Ft. Riley, Kansas.

<u>Paraparchites humerosus kansasensis</u> Harris and Lalicker, 1932, Amer. Midl. Nat., 13, no. 6, p. 396, pl. 36, figs. 1a-b.

<u>Paraparchites humerosus spinosus</u> Upson, 1933, Nebr. Geol. Surv., Bull. 8, p. 13, pl. 1, figs. 2a-b.

<u>Paraparchites oviformis</u> Upson (not Coryell and Rogatz), 1933, Nebr. Geol. Surv., Bull. 8, p. 13, pl. 1, figs. 3a-b; Wreford formation, Kansas.

Original description: Length of large example, 1.8 mm; height of same, 1.25 mm; thickness of same, 1.05 mm.

Carapace subovate, with the outline slightly angulated in the antero-dorsal region; surface rather strongly convex with the greatest thickness near middle of valves. Left valve with dorsal edge straighter than in right valve, the edge in the latter being convex in outline and thickened so that it projects above the hinge line of the left valve. Ventral edge of carapace thick and slightly channeled on each side of the constant line between the valves.

The following emended description for this species is presented to cite characteristics noted by this worker that are not stated in the original description.

Emended description: Carapace large, subovate; greatest height slightly posterior of center; greatest thickness anterior of center, tapering evenly toward all margins; hinge short, depressed and straight; dorsal margin of right valve straight, left valve faintly convex where it projects above the right valve; ventral margin slightly convex tapering into broadly rounded anterior and posterior extremities, anterior more narrowly rounded; right valve overlapping left around free margins; channeling along free margin adjacent to line of contact of two valves; also a slight depression or channel ventral to center; surface smooth.

Fig. 3. cont.

Measurements of figured specimens in my collection are:

Length	Height	Thickness
1.086 mm	0.762 mm	0.531 mm
1.251 mm	0.872 mm	
1.047 mm	0.770 mm	0.539 mm

Discussion: The specimens in my collection here referred to this species agree with the original generic description in practically every detail. The specific description seems to vary somewhat from the generic description, which causes some doubt in regard to identification of this species. It is quite possible that the variation between the two descriptions was due to an error in writing when the specific description was written.

The rather shallow depression or channel just ventral of center on both valves of this species is a very conspicuous feature which has not been mentioned in any of the descriptions for this species known to this worker. The channeling mentioned in the original description and shown in the illustrations seems to be much closer to the ventral margin. It is possible that the specimens used for the type were weathered enough to obscure this characteristic completely.

Another difference noted is the continuation of the channel, adjacent to the free margin, around the entire free margin. The plausible explanation to this deficiency in description is also the unweathered condition of the specimens in my collection. The specimens from the Howe limestone member of the Red Eagle limestone are somewhat weathered and do not show these features.

Occurrence: P. humerosus is one of the most common ostra-

Fig. 3.(cont.)

code species found in limestones of the Wolfcamp series. It was found abundantly in the upper part of the Howe limestone member at all locations sampled. P. humerosus occurs commonly in the Kinney limestone member of the Matfield shale, Glenrock limestone member of the Red Eagle limestone, Fort Riley limestone member of the Barneston limestone, and in the persistent limestone near the top of the Speiser shale.

Fig. 4. Major taxonomic division.

Superfamily BEYRICHIACEA Ulrich and Bassler, 1923

Fig. 5. Genera and species of the family primitiidae.

Family PRIMITIIDAE Ulrich and Bassler, 1923

Genus Monoceratina Roth, 1928

Monoceratina Roth, 1928, Jour. Paleo., vol. 2, no. 1, p. 15-19.

Original description: Carapace, sub-oblong, quite tumid, maximum height slightly anterior to the median half, maximum thickness is well down on the antero-ventral side and approximately in the plane of the maximum height. Hinge line is straight, on the posterior extremity the ventral margin is boldly rounded and meets the hinge line at a very obtuse angle, on the ventral side the margin is almost parallel to the dorsal margin for about three-fourths of the length of the hinge line. However, the ventral margin here represented is at a very slight angle to the hinge line and will gradually meet it posteriorly if produced. On the anterior part of the ventral margin there is a rounded obtuse angle toward the hinge line; the anterior part of this obtuse angle is slightly concave, after which it boldly curves inward to meet the hinge line at an obtuse angle. The anterior obtuse angle is of a less degree than the posterior one. This whole anterior part of the ventral margin is somewhat similar to the prow of a vessel. In fig. 1c the dorsal aspect also brings out very nicely the outline of the hull of a vessel. All the carapaces and valves studied have shown the valfes to be nearly equal or as much so as possible. There is a tendency of the left valve to be slightly grooved on the dorsal and ventral sides so that it may receive the right valve. This character is extremely variable and many valves do not show it. This variability is probably due to

Fig. 5. (cont.)

poor fossilization. About five-eighths of the distance toward the posterior end a faint Primitia-like sulcus may be observed which extends toward the hinge line from about the middle of the middle of the valve and almost touches this line. Both valves have a general pitted surface, which gradually fades anteriorly and posteriorly and is very prominent on the horn-like protuberances. This pitted character is concentrically arranged about one pit in the sulcus on some forms, but is not always present, which again may be due to poor fossilization. The horn-like projection is the most interesting thing on these minute forms. In this species it has more the character of a flange and first develops at about seven-eighths of the distance posteriorly. This flange gradually develops until at about three-fourths of the distance posteriorly it has projected downward and outward until it is on a level with the keel of the ventral margin. The maximum development is about three-eighths of the distance posteriorly, at which point it is well below and away from the ventral keel. At this point it terminates in a sharp little horn. Anteriorly from this point the horn-like flange drops back to the carapace at almost right angles and rapidly fades into the very sharp anterior keel of the ventral margin. There is a very pronounced tendency along the whole ventral margin for the valves to meet at a very acute angle which appears almost as a keel or flange.

Genotype: Monoceratinaventralis Roth.

Monoceratina lewisi Harris and Lalicker

Plate I, Fig. 4.

Monoceratina lewisi Harris and Lalicker, 1932, Amer. Midl. Nat., vol. 13, p. 398, pl. 36, figs. 6a,b; Ft. Riley limestone, Kansas. -Kellett, 1935, Jour. Paleo., vol. 9, p. 158, pl. 16, figs. 4a,b; Kanwacka shale to Winfield formation, Kansas. -Cooper, 1946, Ill. Geol. Surv. Bull. No. 70, p. 39, pl. 1, figs. 10-12; Gimlet zone, Illinois.

Triceratina wrefordensis Upson, 1933, Nebr. Geol. Surv., Bull. 8, p. 29, pl. 3, figs. 1a,c; Hughes Creek shale, Nebraska.

Original description: Carapace elongate, tumid, maximum height median; hinge line straight, slightly upturned at the anterior end; anterior extremity acutely pointed, posterior extremity rounded, distinctly proturding backward, prominent forward projecting spine located antero-centrally on ventral margin, inflated node slightly behind center and below the median line, minute tubercle located at the postdorsal angle and set off anteriorly by a slight incision, shallow sulcus posterior to center, free margin depressed,

Fig. 5. (cont.)

flange-like posteriorly and especially anteriorly; surface punctate..
Length, 0.67 mm; height, 0.32 mm.
Fort Riley limestone, Kansas.

Discussion: The specimens in my collection, although somewhat poor, agree in practically every detail with the original description and illustrations given for the type. The only exceptions are the apparent absence of the post-dorsal tubercle and the less prominent antero-central forward projecting spine.

Measurements of the figured specimens are:

Length	Height	Thickness
0.732 mm	0.367 mm	
0.639 mm	0.331 mm	

Occurrence: This species occurs only very rarely in the limestones covered by this investigation. The few specimens found occurred in the Florence limestone member of the Barneston limestone, Locality No. 65.

Fig. 6. Genera and species of the family beyrichiidae.

Family BEYRICHIIDAE Jones,

Genus Hollinella Coryell, 1928

Hollinella Coryell, 1928, Jour. Paleo., vol. 2, no. 4, p. 377-378, pl. 51, figs. 1-3.

Original description: Small, subquadrangular, equivalved, and straight hinge-lined ostracods; the surface of each valve is finely or coarsely granulose with a median sinus lying in the dorsal half, about which an irregular U shaped swelling rises; the dorsal ends of the swelling are raised into prominent lobes, the anterior one larger and more regularly hemispherical than the posterior; the free margin may be bordered with a low ridge, a broken or continuous row of spinelike extensions, or there may be no marginal ornamentation present.

Genotype: Hollinella denta Coryell.

Fig. 6. (cont.)

Hollinella bassleri Knight

Plate II, Fig. 31.

Hollina bassleri Knight, 1928, Jour. Paleo., 2, no. 3, p. 240, pl. 31, fig. 3; pl. 34, fig. 7.

Hollinella bassleri Kellett, 1929, Jour. Paleo., 3, no. 2. p. 197, pl. 25, figs. 5a-c. -Moore, 1929, Denison Univ. Bull. Jour. Sci. Lab., 24, p. 101. -Warthin, 1930, Okla. Geol. Surv., Bull. 53, p. 57, pl. 4, fig. 3. -Coryell and Billings, 1932, Amer. Midl. Nat., 13, no. 4, p. 185, pl. 18, fig. 4.

Hollina buchleri Knight, 1928, Jour. Paleo., 2, no. 3, p. 236, pl. 31, fig. 1, pl. 34, fig. 8.

Hollina fortscottensis Knight, 1928, Jour. Paleo., 2, no. 3, p. 237, pl. 31, fig. 2.

Original description: Outline, neglecting the frill and nodes entirely similar H. buehleri. The anterior node is however slightly less prominent; the frill is reduced to a linear row of papillae or short spines somewhat uneven in length, which occupies the exact position of the frill in preceding species and unquestionably is its morphological equivalent. A second row of spines extends around the ventral and end margins close to the margin of the valve and reaches almost if not quite to the hinge-line at both ends. This latter row is irregularly two ranks deep. The ventral and end margins of the left valve are slightly beveled as in H. buehleri and also carry a marginal row of minute beads. I have no right valves. The surface of the valves is minutely but strinkingly papillose.

Length 0.97 Height 0.56

Specimens were secured from the Upper Fort Scott limestone.

Discussion: The one specimen in my collection referred to H. bassleri is somewhat distorted, but shows the characteristics of this species adequately. The length to height ratio differs from that given for the type specimen and the hemispherical horizontally elongated node is pinched to a point. However, these variations are undoubtedly due to the distortion of the specimen.

The measurements of the specimen in my collection are as follows:

Fig. 6. (cont.)

Length	Height	Thickness
1.17 mm	0.670 mm	0.531 mm

This species is characterized by its semiovate lateral outline, the low slightly elongated hemispherical node, and the median sulcus that extends well under the posterior node.

H. bassleri differs from H. ulrichi Knight in lacking spines on the carapace. It differs from H. digita Kellett in lacking spines and the lower anterior node. H. limbata Moore is more elongate and its nodes are less hemispherical.

Occurrence: Only one specimen of H. bassleri was found, that being in the lower one foot of the Cottonwood limestone member of the Beattie limestone, Locality No. 32.

Hollinella crassimarginata Kellett

Plate II, Fig. 8 and 9.

Hollinella crassimarginata Kellett, 1929, Jour. Paleo., vol. 3, p. 206, pl. 26, figs. 3a-b, 7; Stanton to Ft. Riley formations, Kansas. -Upson, 1933, Nebr. Geol. Surv. Bull. 8, p. 31, pl. 4, fig. 5a; Permian, Nebraska. -Cooper, 1946, Ill. Geol. Surv. Bull., No. 70, p. 89, pl. 13, figs. 25-27.

Original description female: Carapace rhomboidal to sub-rectangular. Anterior margin only slightly rounded and protruding, sometimes however having a backward swing. Posterior margin slightly rounded to extremely so, with the greatest protuberance below the center of the valve making the posterior appear obliquely truncate. Dorsal and ventral margins only slightly rounded and nearly parallel. Hinge and marginal structure that of the genus. Marginal beads on left valve lacking.

Sulcus behind center of hinge line, not deep and often short. Anterior node hemispherical, touching the hinge line, and smaller than that of H. emaciata. Posterior node not much elevated above the posterior surface of the valve. Ridge beneath sulcus not prominent and gently rounding down to frill. Valve with frill presenting a rather flat appearance with only the anterior node standing out prominently.

Fig. 6. (cont.)

Frill thickened, fairly broad posteriorly making a prominent rim at the posterior of the valve which may extend slightly on to the dorsal margin. Frill at the postero-ventral angle flat and paralleling the plane of juncture of the valves, but anteriorly set on at an angle and ending in a short flat spine. Frill of medium width on non-productive female, plate 26, figure 3b; wide on productive female, plate 26, 3a. Frills set on carapace so that when it is closed they are well apart, not close together as on H. emaciata and Hollinella gibbosa Kellett, n. sp. Anterior of valve bordered irregularly by a row of papillae. A few small papillae, sometimes arranged in a row running diagonally downward and backward, in front of the anterior node, and often on the anterior node itself. This arrangement of very sparce, inconspicuous papillae is common to almost all the Hollinellae from Kansas; only on the specimens on H. shawnensis Kellett is the diagonal row missing. Surface slightly granular.

Discussion: Specimens in my collection referred to H. crassimarginata adhere closely to the description given by Kellett for the type species. The few departures noted are: The antero-ventral margin is somewhat inclined, which gives the anterio extremity a narrowly rounded appearance and the posterior margin is only slightly oblique. The anterior node of the right valve is slightly less flattened than that of the left; the posterior node is moderately well developed, and the sulcus between the anterior and posterior node is deeper than original description states.

Since only articulated valves were found, it was impossible to make accurate measurements. The measurements should be made along internal line of contact to avoid differences in the thickness of the carapace and irregularities of the frill.

Measurements of figured specimens are as follows:

Length	Height	Thickness
0.809 mm	0.431 mm	0.416 mm

Fig. 6. (cont.)

This species is characterized by the flattened anterior nodes; presence of indistinct row of papillae in front of anterior node; the prominent rim along posterior margin formed by thickening of frill; and the frill widely separated ventrally.

H. crassimarginata differs from H. emaciata in having the wide-set frill ventrally; anterior node flatter, smaller, and set farther forward; and the prominent ventral ridge is lacking. It differs from most other species of Hollinella in possessing a prominent rim along the posterior margin.

Occurrence: H. crassamarginata occurs rarely in the Schroyer limestone member of the Wreford limestone, Locality No. 57; and rarely in the Florence limestone member of the Barneston limestone, Locality No. 65.

This species, from previous work, is known to occur commonly in the shale break near the bottom of the Threemile limestone member of the Wreford limestone.

Hollinella emaciata (Ulrich and Bassler)

Beyrichia? emaciata Ulrich and Bassler, 1906, U. S. Nat. Mus. Proc., vol. 30, p. 157, pl. 1, figs. 6; Wreford limestone, Kansas.

Hollina emaciata Ulrich and Bassler, 1908, U. S. Nat. Mus. Proc., vol. 35, p. 315.

Hollinella emaciata, Kellett, 1929, Jour. Paleo., vol. 3, p. 202, Pl. 25, figs. 1a-c; Cottonwood and Ft. Riley formations, Kansas. -Cooper, 1946, Ill. Geol. Surv. Bull., No. 70, p. 91, pl. 13, figs. 21-24.

Original description: Length 1.10 mm, height 0.68 mm.

Size shape, and general expression about as in B. radiata, the nodes being more sunken and the ventral portion much less tumid though ridged. A short, vertical curved ridge in the post-dorsal angle and a rim-like border along

Fig. 6. (cont.)

the straight back and anterior end. The flange or frill, which isbent outward at the edge, is not so wide as in B? radiata, surface finely punctate.

Formation and locality-Yellow shales in the Wreford limestone, 6 miles west of Reece, Kansas.

Discussion: The specimens here referred to H. emaciata agree in most respects with the original description. The main differences are: The specimens in my collection seem to be larger; the right valve overlaps the left in the non-productive females; the frill in ventral view parallels the line of commissure, and the distance between the frills is moderate; and the surface varies from slightly punctate to rather granular.

Length	Height	Thickness
1.001 mm	0.708 mm	
1.224 mm	0.693 mm	0.570 mm

Specimens in my collection with the frill absent were assumed to be males, those with a narrow frill non-productive females, and those with a wider frill were assumed to be productive females.

Occurrence: This species seems to be the most abundant and covers a wider range in Wolfcamp limestones than any other species of Hollinellaobserved by this worker. Cottonwood limestone member of the Beattie limestone, all localities sampled, abundant; Crouse limestone member of the Bader limestone, Locality No. 29, common; Burr limestone member of the Grenola limestone, Locality No. 24, rare.

Hollinella nevensis Kellett

Hollinella nevensis Kellett, 1929, Jour. Paleo., vol. 3, no. 2,

Fig. 6. (cont.)

p. 201, pl. 25, figs. 2a-c; Neva and Foraker limestone, Manhattan, Kansas. -Upson, Nebr. Geol. Surv. Bull. 8, p. 35, pl. 4, figs. 6a; Funston limestone, Marshall County, Kansas.

Original description female: Carapace presenting a rectangular appearance, although slightly subrhomboidal; ventral margin approximately paralleling the straight hinge line; length twice the width or less. Anterior margin only very slightly rounded and protruding. Upper half of the posterior margin oblique, and on the narrow frilled form rounded into the ventral margin. The wide frill makes an obtuse angle at the center back of the valve where it suddenly narrows. Hinge and marginal structure that of the genus. Beading along left margin lacking. Valve fairly convex with the surface features having an inflated appearance. A broad fairly deep sulcus located behind the center of the valve. Anterior node with a diameter about half the height of the carapace, hemispherical, placed almost up to the hinge line, and broadly and evenly confluent with the ridge beneath the sulcus. This ridge in turn blends smoothly into the tumid posterior of the valve and the posterior node, but is raised somewhat above the general convexity of the ventral portion. The posterior node is small, and inconspicuous, and raised only slightly above the posterior of the valve. Narrow frill on non-productive female, plate 25, figure 2b, of constant width ventrally and parallel and close to the border of the valve at the postero-dorsal angle; on productive female, plate 25, figure 2c, of moderate width and slightly plicated, not convex, and ending anteriorly in a spine at the outer edge of the frill. It has a pronounced upward plication at the postero-ventral angle, and extends from the center of the posterior margin to posterior cardinal angle as a slight rim composed partly of small tubercles. An irregular row of papillae on the anterior edge and a few short inconspicuous ones may be developed behind them and on the anterior node. Cardinal spines on the right valve prominent. Surface irregularly punctate.

Discussion: The specimens in my collection referred to H. nevensis agree in most respects with the original description given by Kellett for this species. They differ in having a more prominent posterior node and a sulcus that isdeep but not as wide as the original description and illustrations depicted.

Many of the specimens I have classified as H. nevensis are internal casts and therefore, it was impossible to differentiate

Fig. 6. (cont.)

between the wide, narrow, and non-frilled forms. A few narrow-frilled forms were present but imbedded in the matrix which made it impossible to obtain accurate measurements of these specimens.

Measurements of figured specimens are as follows:

Length	Height	Thickness
1.17 mm	0.562 mm	
0.862mm	0.508 mm	0.354 mm

H. nevensis is characterized by its broad confluent anterior node; the prominent ventral ridge that blends into the somewhat tumid posterior and the parallelism of the dorsal and ventral margin.

This species closely resembles H. emaciata Ulrich and Bassler but is differentiated by its greater tumidity, the larger anterior node and the absence of the marked depression between anterior node and the ventral ridge. H. nevensis differs from most other species of Hollinellain having more nearly parallel margins.

Occurrence: H. nevensis occurs abundantly as internal casts in the Crouse member, Locality No. 42. This species also occurs rarely at other stratigraphic horizons in the Wolfcamp series.

The type specimen was described from the Neva member by Kellett (26), where it occurs only rarely, Locality Nos. 27, 29, 30.

Fig. 7. Genera and species of the family kloedenellidae.

Family KLOEDENELLIDAE Ulrich and Bassler, 1923

Genus Coryella Harris and Lalicker, 1932

Coryella Harris and Lalicker, 1932, Amer. Midl. Nat., vol. 13, no. 6, p. 397.

Original description: Carapace small, hollinelloid in outline, with pronounced backward swing; elongate, median sulcus extending to center, with prominent, anterior spine and low posterior node, slight incision slightly behind post-dorsal angle, carapace inflated by a posterior ventral ridge which is terminated anteriorly by a blunt spine, surface otherwise smooth.

Genotype: Coryella stovalli Harris and Lalicker.

Coryella stovalli Harris and Lalicker

Plate II, Fig. 10 and 11.

Coryella stovalli Harris and Lalicker, 1932, Amer. Midl. Nat., 13, no. 6, p. 397, pl. 36, fig. 3a-c; Wreford limestone, Kansas. -Upson, 1933, Nebraska Geol. Surv. Bull. 8, p. 50, pl. 3, figs. 2a-c; Havensville shale, Randolph, Kansas.

Original description: Carapace small, sub-quadrate in outline with straight hinge and pronounced backward swing; posterior extremity evenly rounded. Carapace inflated ventrally in a ridge-like swelling that parallels the free margin posteriorly and ventrally and terminates in a blunt spine in the anterior quarter, slightly post-central sulcus extends downward to the median line, a prominent, dorsal, forward-projecting spine located in front of sulcus on level with hinge line, lower swelling behind, somewhat farther removed from the hinge line, a short V-like incision located in front of the post-dorsal angle.

Length, 0.59 mm.; height, 0.34 mm.

Discussion: The specimens here referred to C. stovalli agree in most respects with the description and illustrations given for the type. The only exceptions are the larger size of the specimens in my collection and the slightly less prominent spines.

Measurements of figured specimens are:

Fig. 7. (cont.)

Length	Height	Thickness
0.578mm	0.331mm	0.270mm
0.647mm	0.339mm	0.362mm
0.648mm	0.347mm	.293mm

Coryella stovalli has been put in synonomy with Sansabella bolliaformis (Ulrich and Bassler) by many workers; therefore, it is the opinion of this worker that reasons should be given for retaining the classification of Harris and Lalicker.

Coryella stovalli differs from Sansabella bolliaformis in the prominent antero-dorsal spine and in the highly inflated ventral ridge that terminates in a prominent antero-ventral spine. These are the two differences stated in the original description, but I believe that other characteristic ones should be given.

Differences between Coryella stovalli and Sansabella bolliaformis noted by this worker are as follows: the hinge line of Coryella stovalli is not deeply incised and channeled; terminal ends are not notched as in Sansabella bolliaformis; length of hinge relative to total length is longer than in S. bolliaformis; and overlap less prominent. The most profound difference is the tendency toward elongation of Coryella stovalli inasmuch as the length to height ratio increases as the size of specimens increases. The average length height ratio of a number of specimens of C. stovalli, 1.9 mm; average of Sansabella bolliaformis, 1.7 mm. Along the line of commisure the right valve possesses a pronounced channel that is not present on specimens referred to S. bolliaformis.

The differences stated above seem adequate reasons for not

Fig. 7. (cont.)

placing these specimens in synonomy with S. bolliaformis and I believe they should be referred to Coryella stovalli.

Occurrence: This species occurs rarely to commonly in practically every limestone in the Wolfcamp series. The only exception being those limestones that were found to be barren of ostracodes at every locality.

Genus Lochriella Scott, 1942

Lochriella Scott, 1942, Jour. Paleo., vol. 16, no. 2, p. 155.

Original description: Carapace subrectangular to ovate; cardinal angles obtuse, greatest thickness in posterior half; valves unequal, right overlapping left around free margin; hinge line depressed in channel, channel occupies posterior one-half to two-thirds of dorsal area; valves may or may not be constricted slightly anterior to middle, if constricted a broad shallow sinus is formed. Carapace smooth or reticulate.

Genotype: Lochriella otterensis Scott.

Remarks: This genus is closely related to Sansabella. The posterior position of the channel, the difference in hingement, and the point of greatest thickness readily distinguish it from Sansabella. It can be distinguished from Beyrichella by the absence of a low transverse ridge and by the presence of a channeled dorsum. It differs from Jonesina by the presence of a channel in the posterior portion of the dorsal area and the lack of a distinct sinus. It can be distinguished from Neokloedenella by the presence of an overlap around the free margin.

Lochriella sp.

Description: Carapace large, subrhomboidal; tumid in posterior region; greatest height one third distance from posterior margin; greatest thickness about the same; dorsal margin high and broadly rounded posteriorly, becoming straight and inclined downward anteriorly; ventral margin straight to very slightly concave medially; anterior margin semicircular and slightly produced;

Fig. 7. (cont.)

posterior margin almost perpendicular; hinge line depressed forming a channel in posterior six-tenths of dorsal margin, terminating in moderate sized triangular tongues; antero-central region somewhat constricted, which causes anterior one half of carapace to be much thinner than posterior; from just in front of postcardinal angle a faint ridge parallels the hinge line, terminating about one-third the distance from anterior margin; surface finely punctate.

Measurements of right valve:

Length	Height	Thickness
1.101 mm	0.693 mm	

Discussion: The lone right valve described above is the only representative of Lochriella found during this investigation, and so far as known to me is the only specimen of this genus described from the Permian system. All other identifications have been made from older stratigraphic horizons. The Genotype Lochriella otterensis Scott, 1942, was described from the Chester series in Indiana. In 1946, Cooper ( ) extended the genus into the Pennsylvanian system, and in doing so proposed three new species.

The above description is in no way an attempt to establish a new species, but merely to propose an extension of the range of Lochriella into the Wolfcamp series. It is the opinion of this worker that this isa new species, but because only one valve was found an adequate description for a new species could not be made.

Fig. 7. (cont.)

Occurrence: The one specimen was found in the Eiss member, Locality No. 38.

Genus Sansabella Roundy, 1926

Sansabella Roundy, 1926, U. S. Geol. Surv., Prof. Pap. 146, p. 5.

Original description: Carapace small, less than 2 millimeters in length; outline varying somewhat from a parallelogram; greatest thickness in anterior half. Left valve larger than right, overlapping on ends and ventral margin. Hinge line straight, equal in both valves and, in part, slightly lower than dorsal margins of the two valves, giving an excavated or channeled appearance in the dorsal view of a bivalved specimen. The hinge structure consists of a longitudinal groove and tongue on each valve; on the left valve the upper or dorsal margin of the groove is slightly larger and forms the tongue; on the right valve the lower margin of the groove is considerable stronger and forms the tongue.

Genotype: Sansabella amplectans Roundy.

Sansabella bolliaformis (Ulrich and Bassler)

Beyrichiella bolliaformis Ulrich and Bassler, 1906, U. S. Nat. Mus. Proc., vol. 30, p. 158, pl. 11, fig. 7,8; Cottonwood formation, Kansas.

Jonesina bolliaformis, Ulrich and Bassler, 1908, idem. vol. 35, pl. 44, figs. 3-5. -Kellett, (part), 1933, Jour. Paleo., vol. 7, p. 78, pl. 14, figs. 1-8, 17-19, 32-36; Cottonwood formation, Kansas. -Cooper(part), 1946, Ill. Geol. Surv. Bull., No. 70, p. 115, pl. 19, figs. 14-17; "Centralia" zone, Illinois.

Original description: Length 0.87 mm; height 0.52 mm, thickness 0.35 mm.

Carapace rather elongate subovate, the posterior end wider and more oblique than the anterior; cardinal angles obtuse, ends nearly equal in thickness. Surface of valves with two rounded and not very prominent nodes, subcentrally situated, one on either side of the deep median sulcus, nodes generally connected by a more or less obscure loop; posterior node rather better defined though smaller than the anterior. Ventral part of valves swollen without being definitely ridge-like. Dorsum channeled; ends and ventral edge, especially of the left valve, distinctly rimmed. Ventral edge of left valve overlapping that of the right.

Fig. 7. (cont.)

Discussion: Specimens here referred to S. bolliaformis agree in most respects with the original description given for the type. The main differences noted are as follows: length to height ratio, some specimens are more elongate than the type, and others less elongate; most specimens do not show the distinct rim; sulcus variable, from deep to moderately shallow; hinge notched at terminal extremities.

Measurements of figured specimens are:

Length	Height	Thickness
0.739 mm	0.424 mm	0.270 mm
0.732 mm	0.416 mm	0.308 mm

This old, rather well-established speciesof ostracodes has for many years been the catch-all for forms coming anyway near to the original description. Why this condition exists in regard to this species is not understood and it is sincerely believed by this worker that an extended examination would show at least two additional species. Sansabella bolliaformis tumida (Ulrich and Bassler) and Coryella stovalli Harris and Lalicker are two forms that have been placed in synonomy with Sansabella bolliaformis. It is the opinion of this worker that they should not be and reasons for removing them are stated in another part of this paper.

The statement in the original description in regard to the channeled dorsum, and also the tongues at the terminal ends of hinge, not stated in original description, seem adequate reason for referring this species to Sansabella Roundy, which has these characteristics as stated by Roundy when he established the genus.

Fig. 7. (cont.)

Occurrence: This species is found commonly to rarely in all the limestones of the Wolfcamp series that contain an ostracode fauna. The tabulation presented in another part of this paper gives a detailed account of the occurrence.

Sansabella bolliaformis tumida Ulrich and Bassler

Plate II, Fig. 12 and 13.

Beyrichiella bolliaformis tumida Ulrich and Bassler, 1906, idem, p. 158, pl. 11, figs. 9, 11; Cottonwood formation, Kansas.

Jonesina bolliaformis tumida, Ulrich and Bassler, 1908, U. S. Nat. Mus. Proc., vol. 35, pl. 44, figs. 3,5. -Kellett, (part), 1933, Jour. Paleo., vol. 7, p. 78, pl. 14, figs. 1,8,17,19, 32,36; Cottonwood formation, Kansas. -Cooper (part), 1946, Ill. Geol. Surv. Bull., No. 70, p. 115, pl. 19, figs. 14,17; "Centralia" zone, Illinois.

Jonesina garrisonensis Upson, 1933, Nebr. Geol. Surv., Bull. 8, p. 48, pl. 3, fig. 9a,b; Middleburg limestone, Nebraska.

A comparison between this variety and Sansabella bolliaformis was given by Ulrich and Bassler instead of a formal description; therefore, an emended description is here presented for this variety.

Emended description: Carapace somewhat rhomboidal in lateral view, tumid especially in antero-dorsal region; anterior margin oblique and tapering back only slightly, posterior margin semi-circular; ventral margin convex, dorsal margin slightly bowed upward; greatest height posterior in one third; greatest thickness just back of anterior margin; hinge long, depressed, channel prominent; wedge-shaped in dorsal view; ventral margin shows a prominent rim on left valve; anterior node very gibbous, posterior node inconspicuous, nodes separated by a moderately

Fig. 7. (cont.)

shallow median sulcus terminating v entrally in pit-like structure; small well-defined incision slightly anterior to and below the postero-cardinal angle; left valve larger than right and overlapping around entire face margin; surface smooth.

Measurements of figured specimens:

Length	Height	Thickness
0.886 mm	0.470 mm	0.416 mm
0.785 mm	0.431 mm	0.336 mm

Discussion: This species is characterized by its very tumid outline, the somewhat rhomboidal appearance, and the shallow median sulcus terminating in a pit-like structure ventral of center.

S. bolliaformis tumida differs from S. bolliaformis in b eing more tumid, more tapering both laterally and in dorsal view, and the dorsum appears to be less channeled.

Occurrence: S. bolliaformis tumida occurs abundantly in many of the limestones of the Wolfcamp series. In the Middleburg memb er it constitutes the entire ostracode fauna, Locality No. 39. At Locality No. 40, which is the same stratigraphically, it is not the only ostracode species found, but it is the dominant one. The dominance and independent occurrence of S. bolliaformis tumida at many stratigraphic horizons covered by this investigation are contrary to ideas proposed by some authors. Kellett (27) and Ulrich and Bassler (45), inferred that specimens of this variety occur only rarely and are usually associated with S. bolliaformis, which conclusion is not substantiated by this investigation.

Fig. 7. (cont.)

The occurrence of this variety is perhaps the most valid reason for separating it from S. bolliaformis.

Fig. 8. Genera and species of the family kirkbyidae.

Family KIRKBYIDAE Ulrich and Bassler

Genus Amphissites Girty, 1910

Amphissites Girty, 1910, New York Acad. Sci., Ann., vol. 20, p. 235.

Description: Carapace small to moderately large, subrectangular; ends broadly rounded and nearly equal; dorsal margin straight; ventral margin straight to slightly convex; cardinal angles obtuse; hinge line usually depressed; left valve larger than right, inner edge rabbeted to receive right; surface usually possessing shoulder-like areas, nodes, ridges, flanges, and fine to moderately coarse reticulations.

Genotype: Amphissites rugosus Girty.

Amphissites pinquis (Ulrich and Bassler)

Original description: Length 0.64 mm, height 0.37 mm, thickness 0.38 mm.

Carapace rather small, thick, suboblong, ends blunt in edge views, nearly equal and rounded in side view; anterocardinal angle obtuse, the posterior angle quite indistinguishable, ventral margin gently convex, the central portion nearly straight; dorsal outline straight in the anterior half of the back being slightly impressed at the hinge line. Surface of valve with a subcentrally situated, rather small, and only moderately prominent node, and behind this, with a small sulcus intervening, two less conspicuous nodes placed one above the other, the larger of the two being near the postcardinal angle. Free margins with a narrow but well-defined flat rim. Surface of test neatly reticulated with small meshes. The diagnostic Kirkbyan "pit" is small and situated very near the center of the valve onthe ventral slope of the median node.

Fig. 8. (cont.)

Discussion: One poorly preserved specimen constitutes the entire Amphissites fauna found in the limestones covered by this investigation.

Although the specimen is poorly preserved, a sufficient number of features characteristic of A. pinquis are discernible to make the classification.

Measurements of figured specimens:

Length	Height	Thickness
0.678 mm	0.385 mm	

Occurrence: The only specimens referable to this genus and species were found in the Cottonwood member, Locality No. 5.

Genus Knightina Kellett, 1933

Knightina Kellett, 1933, Jour. Paleo., vol. 7, no. 1, p. 97.

> Original description: Small, elongate, sub-clavate Kirkbyidae with obtuse cardinal angles, the ends rounded, the anterior the more acutely rounded and rather narrow. Free margin o f the left valve rabbeted to take the edge of the right, thus slightly overlapping it. Cardinal teeth and sockets poorly developed if present in this genus. An outer flange extends along the free edge with an inner flange just inside and usually directly above it, so that when viewed from the side only this one flange is apparent and it appears to border the valve. Both flanges are narrow. The prominent anterior shoulder, typically non-carinate, rises near the hinge line and passes downward almost to the inner flange; it has an abrupt anterior face but posteriorly there is only a slight depression or gentle slope. The surface of the valve in front of this anterior shoulder or node is flattened or gently sloping. Except for this one prominent shoulder the valve shows only very gentle convolutions, the central node being represented by a faint ridge tranding obliquely toward the anterior cardinal angle. The muscle spot which is usually rounded or nearly circular, is located in front of this ridge at about mid-length and below the mid-height of the valve.

Knightina binodata Davis, n. sp.

Plate II, Fig. 18 and 19.

Fig. 8. (cont.)

Description: Carapace small, elongate, subrectangular; ends rounded, anterior more narrowly; greatest height one-fourth the distance from posterior end; greatest thickness across anterior nodes; hinge straight, long, and channeled; dorsal margin undulating in lateral view; ventral margin tapering moderately; valves of equal size; anterior node large, flattened and vertically elongate; posterior node only a slightly elevated area; nodes separated by long, vertical, shallow sulcus which extends almost to the outer flange; inner and outer flanges about equally well developed, except in posterior region where the inner flange becomes thickened, and in lateral view it appears to be offset; area between inner and outer flange moderate to well separated; Kirkbyan pit small, obscure and subcentrally located, reticulations moderate to almost nil.

Measurements of figured specimens:

Length	Height	Thickness
0.655 mm	0.339 mm	
0.702 mm	0.362 mm	0.316 mm

Discussion: K. binodata is characterized by its prominent vertically elongated anterior node; well-developed inner and outer flanges; the deep V-shaped channeled hinge; and the offsetting of the inner flange postero-ventrally.

K. binodata n. sp. differs from K. minuta (Harris and Lalicker) in being larger, having a much shallower central sulcus, a posterior node that is only slightly developed, both anterior and posterior nodes are flattened dorsally, and the ventral margin is more tapering.

Fig. 8. (cont.)

The specimens in my collection, all taken from the same location and stratigraphic horizon, show a marked difference in surface reticulations. Some, as stated in the description, show none, others show ones of moderate size, and one specimen shows a definite pattern; the anterior and posterior region are finely reticulated, and the central area is smooth.

Occurrence: This species occurs rarely in the Kinney member, Locality No. 59.

Fig. 9. Major taxonomic division.

Superfamily CYPRIDACEA Dana, 1852

Fig. 10. Genera and species of the family bairdiidae.

Family BAIRDIIDAE Sars, 1887

Genus _Bairdia_ Mc Coy, 1844 or 1846

Bairdia McCoy, 1844, Synopsis characters Carboniferous fossils Ireland, p. 164.

Descriptions: Carapace subtriangular to rectangular; greatest height central; greatest thickness usually near medial area; anterior extremity rounded to slightly beaked; posterior extremity acuminate to narrowly rounded; dorsal margin moderately to strongly convex; hinge line short, and often depressed; left valve larger than right overlapping it along the dorsal margin and in central region of ventral margin; surface smooth to granular.

Genotype: _Bairdia curta_ McCoy

Bairdia beedei Ulrich and Bassler

Plate I, Fig. 19 and 20.

Bairdia beedei Ulrich and Bassler, 1906, U. S. Nat. Mus. Proc., vol. 30, p. 161, pl. 11, figs. 19,20; Cottonwood shale,

Fig. 10 (cont.)

Kansas. -Warthin, 1930, Okla. Geol. Surv. Bull. 53, p. 69, pl. 5, figs. 9a,b; Holdenville formation, Oklahoma. -Upson, 1933, Nebr. Geol. Surv. Bull. 8, p. 16, pl. 1, figs. 4a,c; Garrison shale, Nebr. -Kellett, 1934, Jour. Paleo., vol. 8, p. 123, pl. 14, figs. 1a-h, 2; Upper Pennsylvanian and Permian, Kansas. -Johnson, 1936, Nebr. Geol. Surv. Pap. 11, p. 33, pl. 4, figs. 1,2; Missouri series, Nebraska. -Payne, 1937, Jour. Paleo., vol. 11, p. 282, pl. 38, figs. 9a,b; pl. 39, figs. 1a,b; Hayden Branch formation, Indiana. -Cooper, 1946, Ill. Geol. Surv. Bull., No. 70, p. 41, pl. 1, figs. 35,40; Brereton to Shumway zone, Illinois.

Bairdia hispida Harlton, 1928, Jour. Paleo., vol. 2, p. 140, pl. 21, fig. 14; Cisco, Texas. -Harlton, 1929, Univ. Tex. Bull. 2901, p. 155, pl. 3, figs. 2a,b; Canyon, Texas. -Delo, 1930, Jour. Paleo., vol. 4, p. 163, pl. 12, figs. 14a,b; Pennsylvania, Texas.

Bairdia wrefordensis Upson, 1933, Nebr. Geol. Surv. Bull. 8, p. 22, pl. 2, figs. 5a,b; Wreford limestone, Kansas.

Original description: Length 1.22 mm, height 0.75 mm, thickness 0.52 mm.

Carapace thick, short, subrhomboidal in outline, lanceolate in edge views, the point of greatest thickness being near the middle; overlapping dorsal edge of left valve thick, the ventral overlap also rather wide, posterior extremity bluntly acuminate, the dorsal half of the outline nearly straight in the left valve and barely concave in the right valve, the lower half arching broadly into the ventral margin, anterior extremity less acuminate than the posterior, the outline being rounded in the lower half, nearly straight, in the upper half, and abruptly bent about the midheight. Valves unequal, the left much the larger, and the middle part of its dorsal outline distinctly convex, while the corresponding part of the right valve is sufficiently straightened to form obtuse angles at the ends of the hinge surface of both valve evenly convex and smooth.

Discussion: The specimens here referred to B. beedei meet the original description in almost all respects.

The measurements of the figured specimens are as follows:

Length	Height	Thickness
1.448 mm	0.716 mm	0.585 mm

Some specimens in my collection differ from those described

Fig. 10. (cont.)

by Ulrich and Bassler in having a greater length to height ratio, which tends to give them a more elongate appearance in lateral view. Other specimens seem to be more broadly rounded dorsally and ventrally, and more bluntly acuminate posteriorly. Although these differences are apparent they seem to be only variations within the species and not consistent enough to warrant a change in nomenclature.

B. beedei is very similar to B. marmorea Kellett but differs in being less elongated and tapering. The elongation of B. marmorea when compared with B. b eedei is especially noticeable when the left valves of the two species are compared.

Occurrence: B. beedei is found in practically every limestone covered by this investigation. The occurrence is from rare to abundant.

Baird ia florenaensis Upson

Plate I, Fig. 20 and 21.

Bairdia florenaensis Upson, 1933, Nebr. Geol. Surv., Bull. 8, p. 22, pl. 2, figs. 4a,b; Fort Riley limestone, kansas. - Kellett, 1934, Jour. Paleo., vol. 8, no. 2, p. 137, pl. 14, fig. 4, pl. 18, figs. 1a-d, 2a-d, pl. 19, figs. 1c-2d; Falls City to Fort Riley limestone, Kansas

Original description: Carapace sub-oblong in lateral view; dorsal margin broadly arched, curvature most pronounced over anterior end of hinge, posterior slope long, convex, lower third steeply inclined; anterior slope convex; hinge line short, depressed, located mainly in posterior half; ventral margin usually straight but often concave medially; inclined posteriorly from region of anter-ventral angle; posterior extremity bluntly acuminate, located below median line; anterior extremity broadly rounded, most pronounced dorsally; greatest height about one-third length of shell from anterior end; ventral profile elongate, extremities thick, greatest thickness in median two-thirds; left valve the larger strongly overlapping the right on anterior

Fig. 10. (cont.)

dorsal slope and along ventral median third, remaining overlap of free margin slight; surface smooth.

Length, 1.212 mm; height, .60 mm; thickness, .45 mm.

Discussion: The specimens here referred to B. florenaensis agree in almost every detail with the original description given by Upson for this species.

Measurements of the figured specimens in my collection are as follows:

Length	Height	Thickness
0.971 mm	0.562 mm	0.421 mm
1.186 mm	0.578 mm	0.454 mm

B. florenaensis is similar to many specimens referred to B. ampla Reuss, but differs in being more elongate and having a more depressed hinge line. B. hoxbarensis Harlton differs in lacking the depressed hinge, the antero-dorsal overlap is less prominent and it has a higher anterior beak. B. altiformis Knight has a less sinuate venter and a less depressed hinge line.

Occurrence: B. florenaensis is common in the Long Creek limestone member, Locality No. 17; rare in the Schroyer limestone member, Locality No. 54; and the Florence limestone member, Locality No. 65.

This species occurs more commonly in the shales of the Wolfcamp series than in the limestones. Clark (50) indicated that this is one of the most persistent and common species encountered in the shales of the Wolfcamp series. Kellett (29) also stated that this species made up a substantial part of the ostracode fauna in the Wolfcamp series.

Fig. 10. (cont.)

<u>Bairdia garrisonensis</u> Upson

Plate I, Fig. 10 and 11.

<u>Bairdia garrisonensis</u> Upson, 1933, Nebr. Geol. Surv. Bull. 8, 2nd series, p. 20, pl. 1, figs. 10a,c; Garrison formation, Permian; Kansas-Nebraska line. -Kellett, 1934, Jour. Paleo., vol. 8, no. 2, pp. 134. Lower Permian, Kansas. -Scott and Borger, 1941, Jour. Paleo., vol. 15, p. 354, pl. 49, fig. 19, Macoupin formation, Illinois.

Original description: Carapace large, subrectangular; anterior beak broad and above the mid-height of the valve; posterior beak low and bluntly acuminate; dorsal margin strongly arched; ventral margin very slightly convex; carapace thick in dorsal view; apparent overlap present all around except at the extreme ends of the beaks; dorsal line of contact depressed only along the straight post-dorsal portion.

Measurement of the figured specimen:Length 1.52 mm, height 0.96 mm, width 0.68 mm.

Discussion: The specimens in my collection have a more acuminate posterior extremity than the type and somewhat higher length to height ratio. These are the only significant variations noted between the type specimens and the specimens in my collection.

Measurements of the figured specimens are as follows:

Length	Height	Thickness
1.409 mm	0.878 mm	
1.487 mm	0.847 mm	0.585 mm

<u>B.</u> <u>garrisonensis</u> is very similar to <u>B.</u> <u>radlerae</u> Kellett but differs in lacking the prominent, high anterior beak of <u>B.</u> <u>radlerae</u>. The lack of the prominent anterior beak gives this species a distinctly rounded anterior extremity, which is very conspicuous when the left valve is viewed laterally.

<u>B.</u> <u>oklahomaensis</u> Harlton differs from this species in having a somewhat sinuate ventral margin. This species differs from

Fig. 10. (cont.)

B. elssensis Upson in being more convex ventrally and in having a much lower length to height ratio.

Occurrence: B. garrisonensis was found only in the Cottonwood limestone member, Locality No. 31, and occurs there only rarely. However, it does occur commonly in the Florence shale member, which lies just above the Cottonwood limestone member.

Bairdia incisensis Davis n. sp.

Plate I. Fig. 16 and 17.

Description: Carapace subrhomboidal, tumid, especially in postero-dorsal region; dorsal margin arched; ventral margin straight to slightly convex; anterior end rounded, ending in high peak; posterior end bluntly acuminate, with beak well below mid-height; greatest height slightly anterior of center; greatest thickness central; hinge line short and deeply incised, the incised appearance due to the inflation of the left and right valves along the postero-dorsal slope; antero-dorsal slope long and moderately steep; posterior dorsal slope long and steep; dorsal view shows the inflation of the dorsal margin adjacent to hinge line which gives the appearance of two prominent ridges separated by a deep furrow; actual hinge structure not observed; overlap prominent along antero-dorsal and ventral margins, overlap of postero-dorsal margin less pronounced; surface smooth.

Measurements of figured specimens:

Length	Height	Thickness
0.910 mm	0.593 mm	0.462 mm
0.973 mm	0.616 mm	0.501 mm
0.901 mm	0.593 mm	0.470 mm

Fig. 10. (cont.)

Discussion: B. incisensis is characterized by the widely furrowed area of the hinge, marked overlap along antero-ventral margin, the very steep postero-dorsal slope, and its tumidity.

This species differs from B. blakei Harlton in having a straighter ventral margin; is more inflated in area of hinge; with the hinge more incised; posterior extremity is lower; ventral overlap is more pronounced; and the dorsal margin is somewhat angulated in lateral view in contrast to the semicircular dorsal margin of B. blakei.

B. seminalis Harlton differs from B. incisensis n. sp. in being less inflated dorsally; it has a much less depressed hinge; in lateral view, the dorsal overlap is developed more prominently along the entire dorsal margin and the ventral margin is convex.

B. crassa Harlton is less inflated in the postero-dorsal region; the hinge is not as deeply incised; the dorsal view of B. crassa does not show the two prominent ridges adjacent to the hinge; and the posterior beak is higher.

Occurrence: B. incisensis n. sp. is a common form in the upper part of the Cottonwood limestone member, Locality Nos. 31 and 32. It occurs very rarely in the Long Creek limestone, Locality No. 16.

Specimens very similar to this species were found in the Schroyer limestone member, Locality No. 55, but were so poorly preserved that a conclusive identification could not be made.

Fig. 10. (cont.)

<u>Bairdia</u> <u>marmorea</u> Kellett

Plate I, Fig. 14 and 15.

<u>Bairdia</u> <u>marmorea</u> Kellett, 1934, Jour. Paleo., 8, no. 2, p. 127, pl. 15, figs. 1a-h; Lower Middle Pennsylvanian to Permian (Winfield limestone)

Original description: Carapace rather small; in lateral view anterior end narrowly rounded and slightly above the mid-height of the valve; posterior end pointed and slightly below the mid-height; dorsal and ventral margins evenly arched; greatest height slightly anterior to the center; in dorsal view ends evenly tapered; dorsal line of contact of the valves very slightly if at all depressed and straight in the central part rather than arched.

Measurements of the figured specimens: Figure 1a, length 1.10 mm, height 0.60 mm; figure 1b, length 1.07 mm, height 0.59 mm; figure 1c-d, length 1.06 mm, height 0.58 mm, width 0.39 mm; figure 1e, length 1.01 mm, height 0.58 mm.

Occurrence: Lower Middle Pennsylvanian (in deep well samples as low as the lower part of the Missouri series) to Permian (Winfield limestone).

Discussion: <u>Bairdia</u> <u>marmorea</u> is very similar to <u>B</u>. <u>beedei</u> Ulrich and Bassler and in lateral view the two species look very much alike. <u>B</u>. <u>marmorea</u> is more tapering and the form ratio is higher than <u>B</u>. <u>beedei</u>.

Differences between the specimens in my collection and those described by Kellett are as follows: one specimen is considerably larger than those described by Kellett; the dorsal and ventral margin are not evenly arched and, from the illustrations presented by Kellett, it appears that they are not evenly rounded. The hinge area seems to be slightly impressed.

Measurements of figured specimens:

Fig. 10. (cont.)

Length	Height	Thickness
1.286 mm	0.639 mm	0.51 mm
0.909 mm	0.501 mm	0.37 mm

If the left valve of B. marmorea is compared with specimens of B. beedei, a marked difference is apparent in the more flattened ventral margin and the lower and more elongate nature of B. marmorea.

Occurrence: B. marmorea is found commonly in the Schroyer limestone member, Locality No. 54; rarely at the same stratigraphic horizon, Locality Nos. 55 and 57. This species also occurs rarely in the Cottonwood limestone member, Locality No. 31; and in the Burr limestone member, Locality No. 24.

Bairdia perincerta Kellett

Plate 15, figures 6a-d

Bairdia perincerta Kellett, 1934, Jour. Paleo., vol. 8, no. 2, p. 132, pl. 15, figs. 6a-d; Upper Pennsylvanian, Kansas.

Original description: Carapace moderately high in side view; anterior beak narrowly rounded and high; posterior beak low and pointed; medium part of dorsal margin straight; in dorsal view sides flattened and ends pointed; a narrow horizontal dorsal ridge on the left valve (see figures 6a,6d).

Measurements of the figured specimens: Figure 6a-b, length 1.14 mm, height 0.62 mm, width 0.37 mm. figures 6c-d, length 1.01 mm, height 0.52 mm.

The original description of this species is very brief and fails to mention the characteristics of the hinge line, overlap, and surface texture. Inasmuch as these features are essential to the full description of ostracodes an emended description is here presented.

Fig. 10. (cont.)

Emended description: Carapace moderately elongate and high in lateral view; greatest height slightly anterior of center; greatest thickness central; hinge not well defined but apparently short and only slightly depressed; dorsal margin arched and slightly flattened in central region; ventral margin straight to moderately convex; anterior extremity narrowly rounded and high; posterior extremity low and acuminate; sides tapering to slightly flattened in dorsal view; overlap moderate over entire dorsal margin and moderate to absent in central portion of ventral margin; surface smooth.

Measurements of figured specimens are:

Length	Height	Thickness
1.010 mm	0.531 mm	0.201 mm
0.709 mm	0.400 mm	0.308 mm

Discussion: _B. perincerta_ is very similar to _B. marmorea_ Kellett but differs in being more tapering and haveing a higher dorsum and a much straighter venter. The length to height ratio is about the same for these two species, consequently the other differences stated above must be used in differentiating between them.

Occurrence: This species was found only in the Burr limestone member, Locality No. 24, where it occurs commonly.

Bairdia pompilioides Harlton

Plate II, Fig. 3.

Bairdia pompilioides Harlton, 1928, Jour. Paleo., vol. 2, p. 140, pl. 21, fig. 13; Hoxbar group, Oklahoma. -Harlton, 1929, Texas Univ. Bull. 2901, p. 154, pl. 2, fig. 7; pl. 3, fig. 8; Canyon group, Texas. -Warthin, 1930, Okla. Geol.

Fig. 10. (cont.)

Surv. Bull. 53, p. 70, pl. 5, figs. 1a,b (not figs. 11a,b); Sasakwa limestone group, Oklahoma. -Coryell and Osorio, 1932, Amer. Midl. Nat., vol. 13, No. 2, p. 33; Nowata shale, Oklahoma. -Kellett, 1934, Jour. Paleo., vol. 8, p. 130, pl. 16, figs. 2-4; Stanton limestone to Wreford formation, Kansas. -Bradfield, 1935, Bull. Amer. Paleo., vol. 22, p. 87, pl. 6, figs. 5a,b; Hoxbar group, Oklahoma. -Payne, 1937, Jour. Paleo., vol. 11, p. 284, pl. 39, figs. 7,8; Hayden Branch formation, Indiana. -Scott and Borger, 1941, idem., vol. 15, p. 356, pl. 49, figs. 13, 14; Macoupin formation, Illinois. -Cooper, 1946, Ill. Geol. Surv. Bull., No. 70, p. 49-50, pl. 3, figs. 39-43.

Bairdia subcitriformis Knight, 1928, Jour. Paleo., vol. 2, p. 322, pl. 43, figs. 5a,b; Pawnee limestone, Missouri.

Original description: Shell large, elongately subdeltoid in outline, length about twice the height. Overlapping dorsal border of left valve thick, the ventral overlap moderately strong near the middle. Dorsal border elevated, straight or slightly curved near the middle, dorso-posterior slope slightly concave, dorso-anterior slope with a pronounced conspicuous curve near the middle. Ventral border straight or slightly incurved; anterior extremity rounded, most prominent above, posterior extremity acuminate. Valves inequal, hingement formed by the overlap of the left valve over the right. Length, 1.90 mm; height, 1.0 mm; thickness, 0.7 mm.

Discussion: The specimen in my collection referred to B. pompilioides Harlton agrees in almost every respect with the original description given. As stated by Harlton, this species resembles B. curta var. bicornis Jones and Kirkby, but has less concave dorso-anterior and dorso-posterior slopes. B. verwiebei Kellett resembles this species rather closely, but differs in being smaller and having lower, less acuminate, upturned beaks.

The specimen in my collection is smaller than that described by Harlton and has a higher length to height ratio; the overlap in the antero-dorsal area is not as pronounced but this is probably due to distortion of the specimen.

Fig. 10. (cont.)

Measurements of the figured specimen is as follows:

Length	Height	Thickness
1.425 mm	0.616 mm	0.453 mm

No other species of Bairdia known to this worker closely resembles this species. B. subcitriformis Knight has been placed in synonomy with B. pompilioides by most authors which is also the opinion of this worker.

B. grahamensis Warthin (not Harlton) has been placed in synonomy with B. pompilioides; however, this writer does not agree with this conclusion. The reason for not placing the two species in synonomy is quite obvious after closely scrutinizing Warthin's paper. The error was not one of classificationbut an error in plates and figure numbering. Under the description for B. pompilioides he gave the plate and figure number for B. grahamensis; therefore, the plate and figure numbers with the d escription should be reversed; this is corroborated by the explanation accompanying the illustration plate which is labeled correctly.

Occurrence: Only one specimen of this species was found, that being in the Long Creek limestone member, Locality No. 17.

From previous work by this worker it is known that this species does occur rarely in many of the shales of the Wolfcamp series.

Bairdia radlerae Kellett

Bairdia pecosensis Delo, Upson (not Delo), 1933, Nebr. Geol. Surv. B ull. 8, 2d ser., p. 23, pl. 2, figs. 6a-d; Wreford formation, Permian; Marshall County, Kansas.

Fig. 10. (cont.)

Bairdia radlerae Kellett, 1934, Jour. Paleo., vol. 8, no. 2, p. 125, 126, pl 14, figs. 3a-c; Neva limestone, Wreford limestone, Kansas.

Original description: Carapace rather large, dorsal and ventral margins for the greater part almost parallel in lateral view; anterior beak high, above the mid-height of the valve and rounding broadly into the straight ventral margin; posterior beak well below the mid-height of the valve and fairly acuminate; antero-dorsal margin slightly concave; post-dorsal margin straight and steep; dorsal apparent overlap moderate; hinge line strongly angled at the post-dorsal corner.

Measurements of the holotype; Length, 1.38 mm; height, 0.82 mm.

Discussion: The specimens in my collection agree in almost every respect with the description given by Kellett. The main difference is in regard to dorsal overlap. Kellett states that the overlap is moderate which is in contrast to the specimens in my collection which show strong dorsal overlap. The specimens in my collection are articulated valves and those shown in Kellett's illustrations were of left valves only, which fact undoubtedly explains this difference in opinion.

Bairdia radlerae has a lower posterior beak and is less inflated than B. deloi Kellett. B. radlerae has more acuminate anterior and posterior beaks than B. garrisonensis Upson, is more rounded ventrally, and has a less angulated articulation of the left and right valves.

B. radlerae is very similar to B. menardensis Harlton and possibly should be placed insynonomy. Kellett stated, upon examination of topotype material, that the ends of B. radlerae are less compressed than B. menardensis. The specimens in my collection were originally referred to B. menardensis Harlton, which

Fig. 10. (cont.)

has a stronger dorsal overlap.

Measurements of the figured specimens are as follows:

Length	Height	Thickness
1.363 mm	0.809 mm	0.562 mm
1.409 mm	0.81 mm	0.57 mm

Occurrence: B. radlerae was found only in the Cottonwood limestone member, Locality Nos. 31 and 35. This species also occurs rather commonly, just above the Cottonwood limestone member, in the Florena shale member.

Bairdia reussiana Kirkby

Plate I, Fig. 5 and 7.

Bairdia reussiana Kirkby, 1858, Annals and Mag. of Nat. Hist., 3rd. series, vol. 2, no. 11, p. 326, 327, pl. X, figs. 6, 6a; Tunstall Hill limestone, Durham, England. -Upson, 1933, Nebr. Geol. Surv. Bull. 8, p. 19, pl. 2, fig. 2a; Fourmile limestone, Kansas

Original description: Length 1/22 inch; height 1/45 inch.

Carapace somewhat reniform, flatly convex, smooth. Dorsal margin flatly convex; posterior slope abrupt, deeply sinuate near its juncture with the ventral margin; anterior slope gentle. Ventral margin with a deep sinus near the centre, becoming rapidly convex posteri rly; towards posterior extremity margins of valves produced. Anterior extremity rounded. Posterior extremity beaked. Lateral contour sub-lenticular, with a flat central region, slightly concave and produced posteriorly; greatest diameter one-fourth of length. Flange of left ventral margin anteriorly situate. Hinge with the left dorsal margin overlapping the right, more so centrally than towards extremities.

Found rarely in the fossiliferous limestone of Tunstall Hill.

Discussion: The specimens in my collection agree in every detail with the original description and illustrations given by Kirkby when he established this species.

Fig. 10. (cont.)

Measurements of the figured specimens are as follows:

Length	Height	Thickness
1.11 mm	0.515 mm	0.33 mm
1.14 mm	0.493 mm	0.323 mm

B. reussiana resembles various specimens referred to B. plebia, but differs in having a more sinuate ventral margin, and a higher and more blunt posterior beak. The young of B. verwiebei resemble this species but are less elongate and have a lower posterior beak. B. kingii Reuss resembles this species also, but is less sinuate ventrally and has a less steepened postero-dorsal slope.

Occurrence: B. reussiana occurs commonly in the Glenrock limestone member, Locality No. 18, and rarely in the Kinney limestone member, Locality No. 59.

Fragments of ostracodes very similar to this species were encountered in many of the limestones of the Wolfcamp series but because they were only fragmentary a conclusive identification was impossible.

Bairdia seminalis Knight

Plate I, Fig. 8.

Bairdia seminalis Knight, 1928, Jour. Paleo., vol. 2, p. 32?, pl. 43, figs. 2a-d ; upper Ft. Scott and Pawnee formations, Missouri. -Coryell and Sample, 1932, Amer. Midl. Nat., vol. 13, p. 262, pl. 25, fig. 14; Mineral Wells formation, Texas. -Kellett, 1934, Jour. Paleo., vol. 8, p. 127, pl. 15, figs. 2a-c; Stanton limestone to Nova limestone, Kansas. -Johnson, 1936, Nebr. Geol. Surv. Pap. 11, p. 40, pl. 4, fig. 3; Westerville limestone to Stanton formation, upper Missouri series, Nebraska. -Coryell and Rozanski, 1942, Jour. Paleo., vol. 16, p. 146, pl. 24, fig. 1.

Bairdia tumida Upson, 1933, Nebr. Geol. Surv. Bull. 8, p. 21, pl. 2, figs. 3a-c; Garrisonshale, Nebraska.

Fig. 10. (cont.)

Original description: Outline of the larger (left) valve sub-oval, the entire carapace having a seed-like aspect. Dorsal outline roundly curved, slightly flattened on the antero-dorsal and less so on the post-dorsal slope. No angulation over the post-dorsal end of the hinge. Posterior beak bluntly angular but not conspicuous. Ventral outline roundly and gently curved for its posterior three quarters and more abruptly upward to the somewhat more sharply rounded anterior end. Outline when viewed from above broadly lanceolate and gently convex, the broadest point being about mid-way. The outline of the smaller (right) valve is considerably narrower and sub-oblong. The hingeline is comparatively short being about fifty-five percent of the total length. The dorsal margin of the right valve is flatly arched with a backward slope along the hinge with a steeply rounded post-dorsal and more gradual antero-dorsal slope. The anterior end is somewhat drawn out. The overlap of the left valve is rather pronounced, particularly along the dorsal line. It is even more conspicuous than usual ventrally. The produced anterior end of the right valve however extends forward almost as far as that of the left.

This small Bairdia is easily differentiated from any Carboniferous form with which I am familiar by its small size, rounded outlines, inconspicuous beak and marked overlap.

The dimensions of the two specimens are:

Length	.75 mm	.78 mm
Height L. V.	.43 mm	.53 mm
Width	.35 mm	--

Lower and Upper Fort Scott limestone.

Discussion: B. seminalis differs from most other species of Bairdia in its very sub-ovate form and pronounced dorsal and ventral overlap. It differs from B. blakei Harlton in its prominent dorsal overlap. This species differs from B. incisensis n. sp. in being less inflated along the dorsal margin, has a less depressed or furrowed hinge line, and is more rounded along the ventral margin.

Measurements of the figured specimens are:

Fig. 10. (cont.)

Length	Height	Thickness
0. 747 mm	0.516 mm	
0. 669 mm	0.394 mm	0.306 mm

Occurrence: This species is found commonly in the Cottonwood limestone member at all localities covered in this investigation. B. seminalis is also found rarely in the Threemile limestone member, Locality No. 51.

The Cottonwood and Threemile limestone members were the only ones in which this species was found, but it is known to occur commonly in the shale members of the Council Grove group, and rarely in the Admire and Chase groups.

Bairdia verwiebei Kellett

Plate I, Fig. 9 and 12.

Bairdia verwiebei Kellett, 1934, Jour. Paleo., vol. 8, p. 129, pl. 17, figs. 2a-c; Winfield to Wreford, Kansas. -Cooper, 1946, Ill. Geol. Surv. Bull., No. 70, p. 52, pl. 4, figs. 7,8; Shumway zone, Illinois.

Original description: Carapace small, somewhat elongate; anterior beak rather narrow; slightly above the mid-height of the valve; posterior beak low and bluntly acuminate; dorsal and ventral margins long, almost straight and parallel in the medium portions; post-dorsal margin short and steep; carapace in dorsal view rather thin with spindle-like ends; dorsal apparent overlap conspicuous; hinge line not depressed. The earlier molts are more tumid centrally and more pointed at the extremities than the mature molts.

Measurements of the figured specimens: Plate 16, fig. 1a-b, Length 0.93 mm, height 0.50 mm, width 0.35 mm, 1c-d, length 0.95 mm, height 0.47 mm, width 0.33 mm; 1e, length 0.88 mm, height 0.42 mm; Plate 17, fig. 2a-b, length 0.98 mm, height 0.48 mm, width 0.32 mm, 2c, length 0.97 mm, height 0.45 mm.

Discussion: The specimens in my collection referred to B. verwiebei agree in nearly all respects with Kellett's description

Fig. 10. (cont.)

of the type but differ in being slightly more rounded along the dorsum and venter; in dorsal view they are more spindle shaped than is shown by illustrations of the type specimens. They very closely resemble Bairdia pompilioides Harlton but are much smaller, have a lower length to height ratio, and a steeper antero-dorsal slope. B. reussiana Kirkby has a much higher posterior beak and is not spindle shaped in dorsal view. B. peracuta Warthin is very similar to B. verwiebei but does not have the prominent dorsal overlap.

The measurements of the figured specimens are:

Length	Height	Thickness
0.878 mm	0.447 mm	0.270 mm
0.870 mm	0.446 mm	0.267 mm

Occurrence: B. verwiebei occurs rarely in the Kinney limestone member, Locality No. 59. Specimens similar to this species were found in the Burr limestone member, Locality No. 24.

Genus Bythocypris Brady, 1880

Bythocypris Brady, 1880, Rep. Voy. Challenger, Zool., vol. 1, p. 45.

Description: The original description for this species was based on morphological characteristics as well as a part that pertained to the carapace. The part given by Brady that refers to the carapace is as follows: "--reniform or subreniform in outline, left valve much larger than the right, overlapping on dorsal and ventral margins. Distinguished from Cypris by the unequal valves."

Genotype: Bythocypris reniformis Brady.

Fig. 10. (cont.)

Bythocypris pediformis Knight

Plate II, Fig. 4.

Bythocypris pediformis Knight, 1928, Jour. Paleo., vol. 2, no. 4, p. 326, pl. 44, figs. 3a-c; Labette formation, Missouri. -Warthin, 1930, Okla. Geol. Surv., Bull. 53, p. 74, pl. 6, fig. 6, -Coryell and Osorio, 1932, Amer. Midl. Nat., vol. 13, no. 2, p. 35. -Coryell and Sample, 1932, Amer. Midl. Nat. vol.13, no. 5, p. 267, pl. 25, fig. 18; East Mountain shale, Texas. -Coryell and Booth, 1933, Amer. Midl. Nat., vol. 15, no.3, p. Jour. Paleo., vol. 9, p. 135, pl. 16, figs. 8a-f; Stanton to Ft. Riley limestone, Kansas. -Johnson, 1936, Nebr. Geol. Surv. Pap. 11, p. 43, pl. 4, figs. 13-15; Missouri series, Nebraska.

Argilloecia regularis Upson, 1933, Nebr. Geol. Surv. Bull. 8, p. 27, pl. 3, figs. 4a-b; Hughes Creek shale, Kansas.

Coryellites pediformis Cooper, 1946, (not Knight) Ill. Geol. Surv., Bull. 70, p. 58, pl. 5, figs. 19-21; Seville to Shumway zones, Illinois.

Coryellites ovata Cooper, 1946, Ill. Geol. Surv., Bull. 70, p. 57-58, pl. 5, figs. 7-8; St. David to Newtonzones, Illinois.

Original description: Outline suggesting roughly the imprint of a broad moccasined human foot, the anterior margin forming the heel and the posterior ventral beak the great toe. Posterior and dorsal margin form an unbroken curve from the posterior beak which is in line with the ventral margin to just anterior to the centrally located highest point where the curve flattens very slightly and then curves roundly out to a short radius around the end. The curve of the anterior end meets that of the ventral margin smoothly and that of the ventral margin itself is straight to very slightly concave for its anterior three-fifths, then proceeding posteriorly shows a slight convexity a little behind the middle after which it proceeds nearly straight to the beak. The beak is almost blunt-pointed and gives the appearance of pointing downward. The left valve is the larger extending beyond and overlapping the right a small amount all around, more ventrally than elsewhere. The surface is smooth. The dorsal aspect is narrow ovate, heavier posteriorly and rather fine anteriorly.

Dimensions of the two individuals are:

Length	.65 mm	.61 mm
Height	.36 mm	.36 mm
Width	--	.22 mm

Fig. 10. (cont.)

Discussion: The specimens here referred to Bythocypris pediformis agree in all details with the original description given for the type.

Measurements of figured specimens are as follows:

Length	Height	Thickness
0.554 mm	0.47 mm	0.239 mm

Cooper (9) removed this species from Bythocypris and referred it to Coryellites Kellett. The basis for placing this species in Coryellites was the presence of the straight ventral margin, the lack of a rounded postero-ventral margin, and the somewhat sinuate ventral margin.

The sevenal reasons stated by Cooper seem to be valid but, in the original description of Coryellites, Kellett does not enumerate these characteristics as the bases for establishing this g enus; on the contrary, the feature used by Kellet is the presence of a short, stout, blunt node near the post-ventral angle on the left valve with a depression just anterior to it. Since specimens examined by this worker and referred to Bythocypris pediformis lack the node and spine, I feel that placing this and other similar species in Coryellites is not justifiable.

I agree with the idea sponsored by Cooper that many of the specimens referred to Bythocypris should be reclassified, but I also feel that an adequate description of the genus, if it is to be useful, must be written, otherwise it will only lead to more confusion.

Occurrence: B . pediformis occurs rarely in the Falls City

Fig. 10 (cont.)

limestone, Locality No. 7, and rarely in the upper one foot of the Cottonwood limestone member, Locality No. 31.

B. pediformis, although found only rarely in limestones, makes up an essential portion of the ostracode fauna of the Wolfcamp series because it occurs commonly in many of the shales of this series.

Fig. 11. Genera and species of the family cypridae.

Family CYPRIDAE Baird, 1850

Genus Haworthina Kellett,

Haworthina Kellett, 1935, Jour. Paleo., vol. 9, no. 2, p. 165.

Original description: Carapace small, subtriangular in lateral view, greatest height anterior to the center, left valve overlaps right except in the post-dorsal region where the right valve overlaps the left.

Genotype: Bairdia bulleta Harris and Lalicker.

Haworthina bulleta (Harris and Lalicker)

Plate II, Fig. 21 and 22.

Bairdia bulleta Harris and Lalicker, 1932, Amer. Midl. Nat., vol. 13, no. 6, p. 404, pl. 37, fig. 7. Leuder limestone, Upper Permian; Baylor County, Texas.

Original description: Carapace small, elongate, subtriangular in side view with greatest height at center of posterior half, in dorsal view equally bi-convex; dorsal line rather steeply sloping posteriorly from point of greatest height, while anterior slope is more gently, noses rounded, the anterior the lower and sharper, ventral margin practically straight; overlap of left valve faint, most prominent in center of dorsal margin, ventral line of overlap straight; surface smooth, equally convex.

Length 0.62 mm; height 0.33 mm.

The original description for this species is adequate in regard to general outline, but does not give correct interpretation of the overlap, position of hinge, and orientation; there-

Fig, 11 (cont.)

fore, an emended description, in which these features are described, is here presented.

Emended description: Carapace small, sub-triangular in lateral view; greatest height slightly posterior of center, where it gives the appearance of the apex of a triangle; greatest thickness central; nature of the hinge not definite, but apparently short and straight; valves equally biconvex in dorsal view; anterior slope gently convex, posterior slope moderately steep; left valve larger than right and overlapping slightly around entire margin except along postero-dorsal where the right valve overlaps the left; surface smooth to rather granula.

Measurements of the four figured specimens are:

Length	Height	Thickness
0.655 mm	0.370 mm	0.308 mm
0.656 mm	0.383 mm	0.316 mm

Discussion: The specimens in my collection agree in most respects with the original description given for Bairdia bulleta (Harris and Lalicker). The exception is that of the post dorsal slope, where the right valve reverses and overlaps the left, a condition that is not characteristic of Bairdia.

The nature of the post-dorsal slope was the reason given by Kellett for removing this species from the genus Bairdia, and referring it to a new genus Haworthina.

These specimens are obviously not species of Bairdia McCoy due to the nature of the overlap mentioned above and the tendency toward development of equal anterior and posterior extremities.

Fig. 11. (cont.)

A point that is worthy of mention in regard to this species is the very close resemblance to various specimens often referred to Bythocypris Brady. Unless given close examination, this species could easily be referred to the wrong genus. This condition is magnified if the specimen is weathered enough to obscure the nature of the post-dorsal overlap, which could be the reason for Harris and Lalicker referring this species to Bairdia.

Occurrence: This species occurs rarely in the persistent limestone in the Speiser shale, Locality Nos. 46, 47; rarely in the Crouse limestone member, Locality No. 41; rarely in the Cottonwood limestone member, Locality No. 32; commonly in the Howe limestone member, Locality No. 21. Kellett (29) limited the occurrence of Haworthina bulleta to the Grenola limestone and the Cottonwood limestone member.

Genus Carbonita Strand, 1928

Carbonita Strand, 1926-1928, Arch. Nat., 92, pt. A, no. 8, p. 41.

Description Bassler and Kellett: Equivalved Cytheridae (?) with the surface marked by a small round, central spotted muscle area hollow within and wrinkled by numerous small sinuous longitudinal ridges converging towards the ends.

Genotype: Carbonia agnes Jones.

Carbonita inflata (Jones and Kirkby)

Plate II, Fig. 23 and 24.

Carbonita fabulina inflata Jones and Kirkby, 1879, Annals and Mag. Nat. Hist., ser. 5, vol. 4, p. 34, pl. 2, figs. 15-19; Coal Measures, Scotland.

Bythocypris tumidus Upson, 1933, Nebr. Geol. Surv. Bull. 8, p. 24, pl. 2, figs. 11a-c; Stearns shale, Kansas.

Fig. 11. (cont.)

Carbonita ? tumida, Kellett, 1935, Jour. Paleo., vol. 9, p. 160, pl. 16, figs. 9a-d; Elmdale to Wreford formation, Kansas.

A comparison between this species and Carbonita fabulina Jones and Kirkby was all that was given by Jones and Kirkby; therefore an emended description is here presented.

Emended description: Carapace small, subelliptical, tumid; dorsum arched, highest posterior of center; ends rounded, anterior slightly less than posterior; venter straight to slightly concave; greatest thickness one third distance from posterior extremity; hinge short, depressed; right valve larger than left, overlapping all around except in area of hinge where left valve projects above dorsal margin; overlap strongest along venter; surface finely pitted.

Length	Height	Thickness
0.670 mm	0.439 mm	0.370 mm
0.667 mm	0.385 mm	0.408 mm

Discussion: C. magna (Upson) is similar to C. inflata, but is less tumid, has a higher length to height ratio, the anterior extremity is more produced, and it is more concave along venter. C. fabulina (Jones and Kirkby) is also similar but is less tumid, anterior extremity is narrowly rounded, and the pattern of ventral overlap is different.

On the basis of the excellent illustrations of C. inflata (Jones and Kirkby) this worker believes the forms here discussed can b e referred to the species with confidence. The specimens in my collection are about 0.11 to 0.14 mm smaller and the pattern of the ventral overlap is slightly different than shown in

Fig. 11. (cont.)

illustration of type.

Occurrence: This species was found commonly in the persistent limestone in the Speiser shale at all localities covered by this investigation; this is the only occurrence of this species found in the Wolfcamp series.

Carbonita magna (Upson)

Plate II, Fig. 25 and 26.

Bythocypris tumidus magnus Upson, 1933, Nebr. Geol. Surv., Bull. 9, p. 24, pl. 2, figs. 13a,b; Stearns shale, Kansas.

Carbonita? tumida magna Kellett, 1935, Jour. Paleo., vol. 9, p. 161, pl. 16, figs. 11a-f; Stanton formation to Neva limestone, Kansas.

Whipplella carbonaria Scott, 1944, Jour. Paleo., vol. 18, p. 143, pl. 24, figs. 3-5; Cohn formation, Illinois.

Description: Carapace small, semielliptical, elongate in lateral view; dorsal margin arched evenly, venter straight to slightly concave; ends almost evenly rounded; greatest height central; greatest thickness posterior of center, antero and postero-dorsal slope moderately steep and about equal; extremities broadly rounded, and almost equal; hinge short, being about one-third total length of carapace, depressed; wedge shaped in dorsal view, anterior end produced; right valve larger than left overlapping all around except in area of hinge where left valve is raised above dorsal margin, overlap most pronounced ventrally; surface finely perforated.

Measurements of the figured specimens are:

Length	Height	Thickness
0.701 mm	0.377 mm	0.385 mm
0.647 mm	0.362 mm	0.347 mm

Discussion: C. magna is very similar to C. inflata (Jones and Kirkby), but the latter is more tumid in posterior region, the length to height ratio is lower, and the anterior extremity less is produced.

It is possible that the forms here referred to C. magna (Upson) may be conspecific with C. inflata (Jones and Kirkby), the difference being due to sexes.

A redescription of this species is necessary due to the lack of any mention of the hinge structure in the original description. It is possible that when Upson wrote the original description the specimens in his collection did not reveal the detail as well as the specimens in my collection.

From the illustrations given by Jones and Kirkby for various species of this genus there is not much about this species belong to Carbonita Strand rather than Bythocypris Brady.

Occurrence: Carbonita magna occurs abundantly in the persistent limestone in the Speiser shale member at all localities sampled. This species also occurs rarely in the Falls City limestone, Locality No. 5.

Fig. 12. Genera and species of the family cytheridae.

Family CYTHERIDAE Baird, 1850

Genus Basslerella Kellett, 1935

Basslerella Kellett, 1935, Jour. Paleo., vol. 9, p. 155-156.

Original description: Carapace small, subtriangular in lateral view; venter almost straight, dorsum arched or slightly angled, anterior end broadly rounded or angles and posterior end very low and narrowly rounded to rather pointed; greatest height anterior to the center; greatest thickness central or posterior to the center; venter broad and flat; in dorsal view the posterior end is broader than the anterior end which may be compressed left valve larger than the right and overlapping it except in the post-dorsal region where the hinge line is often slightly depressed, overlap slight except along the anterior and the antero-dorsal portions; ventral overlap narrow and almost straight, slightly wider in front of the center; left valve grooved on the on the inner edge at and just in front of the center of the dorsum to receive the right valve, the genotype showing f aint vertical striations or teeth in the central and widest part of this groove, the striations being coarsest and best defined at the anterior of the groove; calcareous inner lamella of medium and even width around the venter and the ends, only slightly developed dorsally and apparently modified by the hingement; line of concrescence paralleling and lying in close proximity to the inner margin of the calcareous inner lamella; outer surface of carapace smooth except for some fine length wise striations observed on two species.

Genotype: Basslerella crassa Kellett.

Basslerella firma Kellett

Plate II, Fig. 20.

Basslerella firma Kellett, 1935, Jour. Paleo., vol. 9, p. 156, pl. 17, figs. 5a-g; Stanton formation to Winfield limestone, Kansas. -Cooper, 1946, Ill. Geol. Surv. Bull., no. 70, p. 69, pl. 9, figs. 1,2; shales in Seville and Lonsdale limestone, Illinois.

When Kellett proposed this species only a comparison between it and B. crassa Kellett was made, therefore I am presenting a formal description for this species.

Description: Carapace short, small, subtriangular, dorsum highly arched; anterior extremity broadly rounded, posterior

Fig. 12. (cont.)

extremity low and narrowly rounded; greatest height slightly anterior of center, greatest thickness central; hinge short and slightly depressed; postero-dorsal slope steep, antero-dorsal slope rounding evenly into broadly rounded anterior extremity; ventral margin slightly convex; tumid in dorsal view, and somewhat produced anteriorly; overlap slight around entire margin; surface smooth.

Length	Height	Thickness
0.439 mm	0.277 mm	0.239 mm

Discussion: The main differences between the specimen here referred to *B. firma* and the type are: the ventral margin is slightly convex, the anterior end seems slightly more produced, and the overlap is only slight.

B. firma differs from *B. crassa* and *B. obesa* Kellett in being much smaller and less obese.

Occurrence: Only one specimen of this species was found, that being in the Cottonwood limestone member, Locality No. 31.

Family CYTHERELLIDAE Sars 1865 (1866)

Genus *Cavellina* Coryell, 1928

Cavellina Coryella, 1828, Jour. Paleo., vol. 2, no. 2, p. 89, 90, pl. 11.

Original description: Carapace small, elongate, inequivalved; dorsal margin arched; ventral contact nearly straight, slightly convex or concave; anterior end broadly curved; posterior end narrowly curved; the greater acuteness lying above the median linel dorsal view wedge-shaped with the greatest thickness near the center of the posterior one-fourth; right valve is larger than the left, and grooved to receive the left; the margin of the right valve is thickened all around, most on the dorsal and ventral edges; the dorsal margin of the right valve overlaps the left, the ventral and poste rior margins extend beyond and appear like a prominent

Fig. 12. (cont.)

overlap, but the amount of overlap is slight or none at all; the anterior margin is not overlapped, in most cases it is channelled along the contact; the surface is smooth, or finely punctate; within the interior or each valve is a partition that extends inward and partially separates the posterior one-third of the body cavity from the rest; on the inner surface of each valve, lying between the center and the dorsal margin, is a small rounded tubercle.

Genotype: C. pulchella Coryell.

Cavellina edmistonae (Harris and Lalicker)

PlateII, Fig. 27 and 28.

Sansabelloides edminstoni Harris and Lalicker, 1932, idem., p. 402, pl. 37, fig. 5; Garrison shale, Kansas.

Cavellina edmistonae Kellett, 1935, Jour. Paleo., 9, no. 2, p. 147, pl. 18, figs. 6a-f. Upper Pennsylvanian and Lower Permian of Kansas.

Original description: Carapace small, elongate; slightly arched dorsal margin, gently and obliquely truncated anteriorly to produce indistinct angle just in front of the center, ventral margin straight, anterior nose high due to slight antero-ventral oblique truncation, posterior end evenly rounded; overlap of left valve entire, regular, but faint, straight central pit located just above median line, a second v ery faint depression is located above and posterior to the larger pit, median area often granular.
Length 0.53 mm. height 0.23 mm.

Discussion: The specimens here referred to C. edmistonae agree in all respects with the description given by Harris and Lalicker. The sole exception is the lack, in many specimens, of the central pit.

Measurements of figured specimens are:

Length	Height	Thickness
0.616 mm	0.354 mm	0.246 mm
0.670 mm	0.385 mm	0.297 mm

This species is another that has been placed in synonomy with various other genera and species and, with this shifting

Fig. 12. (cont.)

around the literature with regard to this species is very confused. In my opinion, the species should undoubtedly be referred to the genus Cavellina. The general outline in lateral and dorsal view, the nature of the overlap, and the thickened posterior are convincing reasons for this generic assignment.

Many workers have placed C. edminstonae in synonomy with various species of Sulcella but why this has been done I cannot understand because, if the various illustrations presented depict the true characteristics of Sulcella Coryell and Sample, then this species certainly does not belong to Sulcella.

Occurrence: This species occurs abundantly to rarely in practically every limestone covered by this investigation. (For a detailed occurrence of this species, see the table of occurrence in another section of this report.)

Cavellina nebrascensis Geinitz

Cythere nebrascensis Geinitz, 1867, K. Leopoldina-Carolinischen deut. Akad. Naturf. Verh., Bd. 33, p. 2, pl. 1, fig. 2; Waubaunsee group, Nebraska.

Cavellina nebrascensis, Kellett, 1935, Jour. Paleo., vol. 9, p. 146, pl. 18, figs. 1a-h; Burlingame to Neva formations, Kans as. -Lalicker, 1935, idem. p. 744, figs. 1-3c. -not Scott and Borger, 1941, idem, vol. 15, p. 357, pl. 50, figs. 3, 9, 10. -Cooper, 1946, Ill. Geol. Surv., Bull., No. 70, p. 73, pl. 10, figs. 1-4.

Description: Carapace elliptical, moderate sized, tumid; greatest height slightly posterior of center; greatest thickness posterior one third ; dorsal and ventral margin equally convex; ends rounded, anterior more broadly; postero-ventral truncation inconspicuous on mature specimens; wedge shaped in dorsal view; overlap prominent along dorsal and ventral margin, and moderate

Fig. 12, (cont.)

around anterior and posterior extremity; hinge structure not determined; surface smooth.

Measurements of figured specimens:

Length	Height	Thickness
1.348 mm	0.678 mm	0.454 mm
0.724 mm	0.470 mm	0.316 mm

Discussion: The specimens here referred to C. nebrascensis agree in practically every detail with descriptions and illustrations given in papers by Kellett and Harris and Lalicker. Because I was unable to obtain the original paper the classification here used was based upon work done by the above-named workers.

The specimens in my collection are somewhat smaller and slightly less tumid posteriorly than those described by the above workers.

C. nebrascensis differs from C. pulchella in being smaller, showing less postero-ventral truncation, and is more evenly arched along the dorsal and ventral margins.

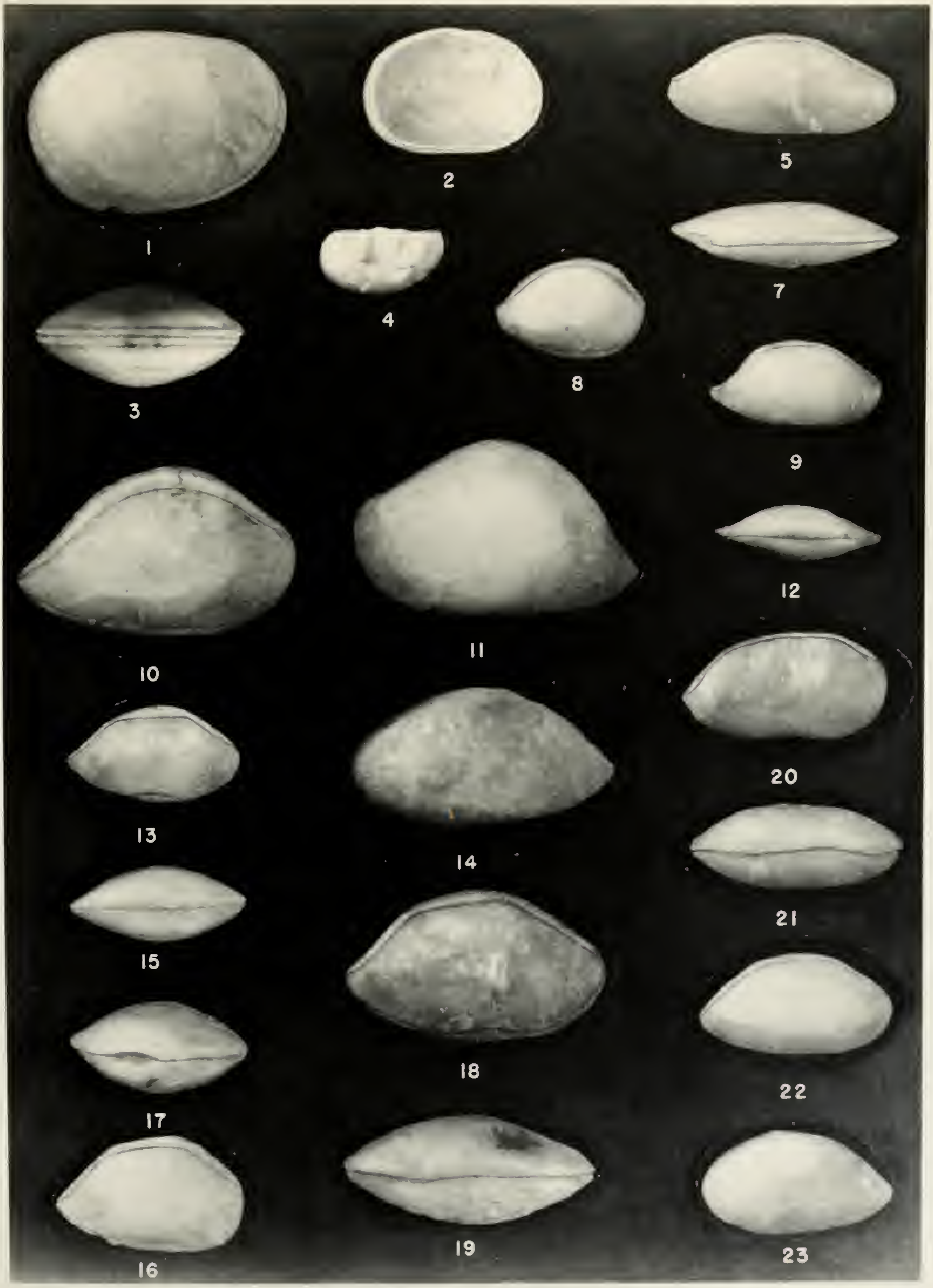
Occurrence: C. nebrascensis occurs rarely in the Five Point limestone, Locality Nos. 10, 11; rarely in the Burr limestone member, Locality No. 24; and rarely in the Funston limestone, Locality No. 44.

EXPLANATION OF PLATE I

(All specimens 30x.)

Fig. 1. Paraparchites humerosus Ulrich and Bassler; lateral view, right valve.
Fig. 2. Paraparchites humerosus Ulrich and Bassler; internal view of left valve.
Fig. 3. Paraparchites humerosus Ulrich and Bassler; ventral view.
Fig. 4. Monoceratina lewisi Roth; lateral view; right valve.
Fig. 5. Bairdia reussiana Kirkby; lateral view, right valve.
Fig. 7. Bairdia reussiana Kirkby; dorsal view.
Fig. 8. Bairdia seminalis Knight; lateral view, right valve.
Fig. 9. Bairdia verwiebei Kellett; lateral view, right valve.
Fig. 10. Bairdia garrisonensis Upson; lateral view, right v alve.
Fig. 11. Bairdia garrisonensis Upson; lateral view, left valve.
Fig. 12. Bairdia verwiebei Kellett; dorsal view.
Fig. 13. Bairdia marmorea Kellett; lateral view, right valve.
Fig. 14. Bairdia marmorea Kellett; lateral view, left valve.
Fig. 15. Bairdia marmorea Kellett; dorsal view.
Fig. 16. Bairdia incisensis n. sp.; lateral view, right valve.
Fig. 17. Bairdia incisensis n. sp., dorsal view.
Fig. 18. Bairdia beedei Ulrich and Bassler; lateral view, right valve.
Fig. 19. Bairdia beedei Ulrich and Bassler; dorsal view.
Fig. 20. Bairdia florenaensis Upson; lateral view, right valve.
Fig. 21. Bairdia florenaensis Upson; dorsal view.
Fig. 22. Bairdia perincerta Kellett; lateral view, right valve.
Fig. 23. Bairdia perincerta Kellett; lateral view, left valve.

Plate I



EXPLANATION OF PLATE II

(All specimens 30x.)

Fig. 1. Bairdia radlerae Kellett; dorsal view.
Fig. 2. Bairdia radlerae Kellett; lateral view, right val
Fig. 3. Bairdia pompilioides Harlton; lateral view, left valve.
Fig. 4. Bythocypris pediformis Knight; lateral view, righ valve.
Fig. 5. Hollinella emaciata (Ulrich and Bassler); lateral view, right valve.
Fig. 6. Hollinella emaciata (Ulrich and Bassler); dorsal view.
Fig. 7. Hollinella nevensis Kellett; lateral view, right valve.
Fig. 8. Hollinella crassamarginata Kellett; dorsal view.
Fig. 9. Hollinella crassamarginata Kellett; lateral view, right valve.
Fig. 10. Coryella Stovalli Harris and Lalicker; lateral view, right valve.
Fig. 11. Coryella Stovalli Harris and Lalicker; dorsal val
Fig. 12. Sansabella bolliaformis tumida (Ulrich and Bassler); dorsal view.
Fig. 13. Sansabella bolliaformis tumida (Ulrich and Bassler); lateral view, right valve.
Fig. 14. Sansabella bolliaformis (Ulrich and Bassler); dorsal view.
Fig. 15. Sansabella bolliaformis (Ulrich and Bassler); lateral view, right valve.
Fig. 16. Lochriella sp.; lateral view, right valve.
Fig. 17. Amphissites pinquis (Ulrich and Bassler); lateral view, left valve.
Fig. 18. Knightina binodata n. sp.; dorsal view.
Fig. 19. Knightina binodata n. sp.; lateral view, left val
Fig. 20. Basslerella firma Kellett; lateral view, left val
Fig. 21. Haworthina bulleta (Harris and Lalicker); lateral view, left valve.
Fig. 22. Haworthina bulleta (Harris and Lalicker); dorsal view.
Fig. 23. Carbonita inflata (Jones and Kirkby); lateral vie left valve.
Fig. 24. Carbonita inflata (Jones and Kirkby): ventral vie
Fig. 25. Carbonita magna (Upson); lateral view, left valve.
Fig. 26. Carbonita magna (Upson); dorsal view.
Fig. 27. Cavellina edmistonae (Harris and Lalicker); dorsal view.
Fig. 28. Cavellina edmistonae (Harris and Lalicker); lateral view, left valve.
Fig. 29. Cavellina nebrascensis Geinitz; lateral view, left valve.
Fig. 30. Cavellina nebrascensis Geinitz; dorsal view.
Fig. 31. Hollinella bassleri Knight; lateral view, right valve.

Plate II

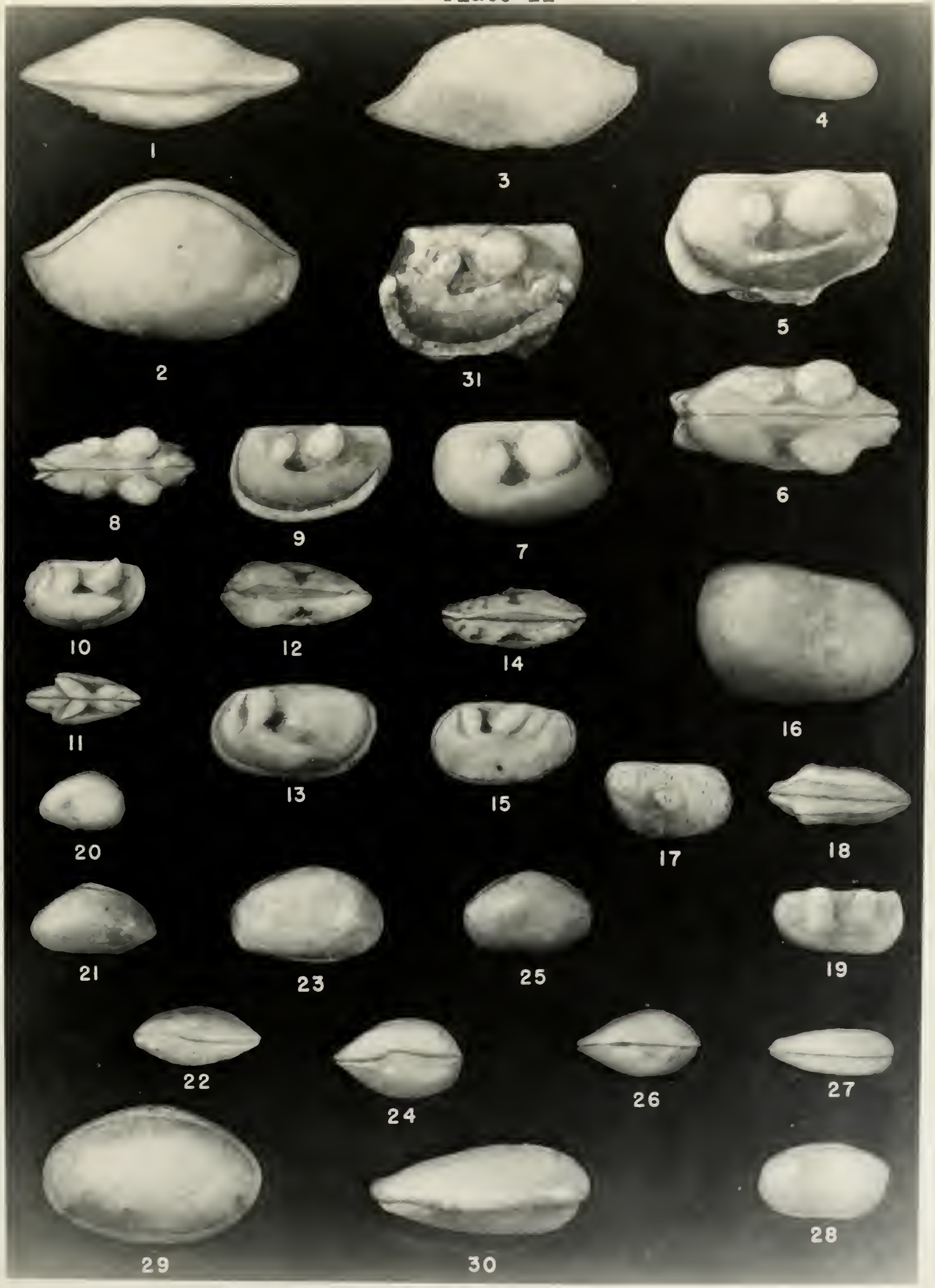

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Table 1. Stratigraphic occurrences and abundance of species.

Genera and Species	Aspinwall ls. (1-3)	Falls City ls. (4-7)	Five Point ls. (8-11)	Houchen cr. ls. (12)	Americus ls. (13-15)	Long Cr. ls. (16-17)	Glenrock ls. (18-19)	Howe ls. (20-23)	Burr ls. (24-26)	Neva ls. (27-30)	Cottonwood ls. (31-33)	Morrill ls. (34-36)	Eiss ls. (37-38)	Middleburg ls. (39-40)	Crouse ls. (41-43)	Funston ls. (44-45)	Speiser ls. (46-49)	Threemile ls. (50-53)	Schroyer ls. (54-57)	Kinney ls. (58-62)	Florence ls. (63-65)	Fort Riley ls. (66-68)	Towanda ls. (69-72)	Stovall ls. (73-74)	Cresswell ls. (75-77)	Krider ls. (78-79)	Herington ls. (80-82)
Amphissites pinquis											R																
Bairdia beedei						R		R	C	R	C	[illegible]	R		A	R	R	R	R	R				R			
Bairdia florenaensis						C				R	C								R		R						
Bairdia garrisonensis										R		R															
Bairdia incisensis						R						C			R				R								
Bairdia marmorea									R			R															
Bairdia perincerta?									C																		
Bairdia pompilioides						R																					
Bairdia radlerae												R															
Bairdia reussiana					R		C			R		R		R							C	R					
Bairdia seminalis												R							R								
Bairdia verwiebei																					C						
Basslerella firma												R															
Bythocypris pediformis		R																									

Table 1. (concl.)

Genera and Species	Aspinwall ls. (1-3)	Falls City ls. (4-7)	Five Point ls. (8-11)	Houchen cr. ls. (12)	Americus ls. (13-15)	Long Cr. ls. (16-17)	Glenrock ls. (18-19)	Howe ls. (20-23)	Burr ls. (24-26)	Neva ls. (27-30)	Cottonwood ls. (31-33)	Morrill ls. (34-36)	Eiss ls. (37-38)	Middleburg ls. (39-40)	Crouse ls. (41-43)	Funston ls. (44-45)	Speiser ls. (46-49)	Threemile ls. (50-53)	Schroyer ls. (54-57)	Kinney ls. (58-62)	Florence ls. (63-65)	Fort Riley ls. (66-68)	Towanda ls. (69-72)	Stovall ls. (73-74)	Cresswell ls. (75-77)	Krider ls. (78-79)	Herington ls. (80-82)
Carbonita inflata																	A										
Carbonita magna		R															A										
Cavellina edmistonae											C		R		R		VR					R		R			
Cavellina nebrascensis			R						R							R											
Coryella stovalli				C								A		R			C										
Haworthina bulleta							R		CR			R			R		R										
Hollinella bassleri												R															
Hollinella Crassamarginata																					R						
Hollinella emaciata				R								C					R			R		VR					
Hollinella nevensis									AR						C							C					
Knightina binodata																				R							
Lochriella sp.													R														
Monoceratina lewisi																		R			R						
Paraparchites humerosus				R			CA										C		C			C					
Sansabella bolliaformis				C								C	R				C				C						
Sansabella bolliaformis tumida				A											A		C					A					

SUMMARY AND CONCLUSIONS

Stratigraphic Distribution

The following is a summary of the tabulation (Table 2) of the ostracode species found in the stratigraphic units covered by this investigation. This summary contains the complete stratigraphic nomenclature for each unit because, to conserve space, it was not given in the tabulation. No attempt has been made to give the occurrence above or below the units covered, therefore, when reference to the occurrence of the microfossils is made it applies only to the units covered by this investigation.

Aspinwall Limestone. This formation was entirely barren of ostracodes at the locations sampled. It does, however, contain brachiopod fragments, echinoid spines, and conodont (?) fragments.

Falls City Limestone. Only two species of ostracodes were found in this unit. This was the first appearance of *Carbonita magna* which occurred only rarely in this unit but does become abundant higher in the geologic column. *Bythocypris pediformis* made its first and only appearance in this unit. Scattered fragments of brachiopods and immature specimens of *Squamularia sp.* were found. The occurrence of *Squamularia sp.* is discussed in another section of the summary.

Five Point Limestone. *Cavellina nebrascensis* makes up the entire ostracode fauna found in this unit, and occurs here only rarely. The other microfossils found in this unit are brachiopod spines, echinoid spines, crinoid fragments, conodonts (?) and high-spired gastropods. This unit proved to be one of the most disappointing because from examination of the field samples it appeared to have an abundance of microfossils.

Houchen Creek Limestone Member of the Hamlin Shale. In contrast to the Five Point limestone, this unit appeared to be nonfossiliferous in the field samples but was found to have good ostracode fauna. The following species make their first appearance: Sansabella bolliaformis tumida, which is the dominant species; Sansabella bolliaformis, which occurs commonly; and Paraparchites humerosus, Hollinella emaciata, Coryella stovalli and Bairdia reussiana, all of which occur only rarely. Brachiopod fragments and Polypora sp. occur commonly.

Americus Limestone Member of the Foraker Limestone. This unit was found to be barren of ostracodes at the localities sampled.

Long Creek Limestone Member of the Foraker Limestone. The first appearance of four ostracode species occurs in this unit. They are: Bairdia pompilioides which is represented by one specimen, B. incisensis n. sp., which occurs rarely in this unit but b ecomes common higher in the geologic column; B. florenaensis which occurs commonly, and B. beedei which occurs rarely in this unit but is persistent in most of the highe r ones. Fusulinids occur commonly in this unit along with brachiopod and echinoid spines. This unit proved to be a disappointment because it was believed that ostracodes occurred more commonly.

Glenrock Limestone Member of the Red Eagle Limestone. The ostracode fauna represented in this unit is Bairdia reussiana which occurs commonly as well preserved specimens; Paraparchites humerosus which occurs commonly and Haworthina bulleta which occurs rarely and makes its first appearance in the limestones covered by this investigation. Fusulinids do occur commonly at some locations and are entirely absent at others. The only other organic remains found in this unit were conodont fragments.

Howe Limestone Member of the Red Eagle Limestone. The dominant forms found in this unit were Paraparchites humerosus, which occurs very abundantly at the top of this unit and actually seemed to be rock forming at some locations, and Haworthina bulleta which occurs commonly. The only other ostracode species found was Bairdia beedei which occurs rarely. High-spired gastropods were found at some locations.

Burr Limestone Member of the Grenola Limestone. This unit at some locations proved to be very fossiliferous and others almost barren. Sample No. 24, from this unit, was one of the most abundant zones sampled, and possesses a well diversified ostracode fauna which includes the following species: Bairdia beedei, which occurs commonly and shows considerable variation within the species; B. perincerta, which occurs commonly and is not found in any other unit; B. marmorea, which occurs rarely; B. reussiana, which is rare; Cavellina nebrascensis, which is rare; and Haworthina bulleta, which occurs rarely. The one other species found in this unit is Paraparchites humerosus which occurs rarely at some localities. This unit, in addition to a good ostracode fauna, contains fragments of brachiopods, echinoid, foraminifers and pavement-type conodonts.

Neva Limestone Member of the Grenola Limestone. The ostracode fauna of this unit was very poor and consisted of the following species: Bairdia beedei, which occurs rarely; B. florenaensis, which occurs rarely but is the dominant species. B. garrisonensis, which is rare and makes its first appearance; and Hollinella novensis, which occurs rarely in the consolidated limestone but does occur commonly in the shale breaks within this unit. Very little other material of organic origin was found.

Cottonwood Limestone Member of the Beattie Limestone. This unit was by far the most fossiliferous zone sampled. It possessed an abundant and diversified ostracode fauna which represented most of the species found in the other units. The ostracode species found in this unit were: Amphissites pinguis, which is represented by one very poor specimen; Bairdia beedei, which occurs commonly; B. florenaensis, which occurs commonly but is less abundant than B. beedei; B. garrisonensis, which is found no higher in the geologic column; B. incisensis n. sp., which becomes common in the upper part of this unit; B. marmorea occurs rarely; B. radlerae, which is found only in this unit; B. reussiana, which occurs rarely as very poorly preserved specimens; B. seminalis, which occurs commonly in this unit but is only represented in one higher unit and there only poorly; Basslerella firma, which makes its only appearance in this unit; Cavellina edmistonae, which occurs commonly; Coryella stovalli, which occurs rarely; Haworthina bulleta, which is represented by excellent specimens but occurs rarely; Hollinella bassleri, which makes its only appearance in this unit and is represented by only one very poor specimen; N. emaciata, which is common but is represented entirely by narrow frilled forms that are somewhat larger than specimens found in the other units; and Sansabella bolliaformis, which occurs commonly.

The other microfossils found in this unit occur commonly and are relatively well preserved specimens, but are not as diverse as the ostracodes. The most common ones found are: Nodosinella sp., which occurs rarely; fusulinids, which occur abundantly in the upper part but are rare in the lower part; and Globivalvulina sp., which occurs rarely.

Morrill Limestone Member of the Beattie Limestone. The only ostracode species found in this unit was Bairdia beedei which occurs rarely. The other fossils remains encountered were scattered brachiopod spines and a few fusulinid fragments.

Eiss Limestone Member of the Bader Limestone. This unit possesses a very poor ostracoda fauna in the consolidated limestone but does have a good one in the shale break in its middle part. The ostracode species found in this unit were: Bairdia beedei, which occurs rarely; Cavellina edmistonae, which occurs rarely; Sansabella bolliaformis, which occurs rarely but is the dominant species in this unit; and Lochriella which made its first and only appearance in this unit and, so far as known to me, has not been previously found in rocks of Permian age. The other fossil material found in this unit consisted of brachiopod spines, echinoid spines, low-spired gastropods, and arenaceous foraminifers.

Middleburg Limestone Member of the Bader Limestone. The ostracode fauna of this unit if dominated by Sansabella bolliaformis tumida which occurs abundantly, and Bairdia reussiana and Coryella stovalli which occur only rarely. The other fossil remains are rare brachiopod spines, echinoid spines, and trilobite (?) fragments.

Crouse Limestone. The ostracode fauna of this unit if fairly abundant but not well diversified. The ostracode species found are: Bairdia beedei, which occurs abundantly and is reresented by some of the best specimens encountered in this investigation; B. incisensis, which is very rare; Cavellina edmistonae, which is rare; Coryella stovalli, which occurs rarely, but is represented by very good specimens; Hollinella nevensis, which occurs commonly but is represented mostly by internal casts; and Sansabella bolliaformis, which is common and shows the more definite "Bollia" appearance not observed in specimens from the other units. The middle part of this unit contains high and low-spired gastropods and micropelecypods.

Funston Limestone. The ostracode fauna of this unit was made up of Bairdia beedei, Cavellina edmistonae, and Cavellina nebrascensis, all of which occur only rarely. The other microfossils in this unit consisted of Worthenia ? sp., which occurs commonly; Globovalvulina sp., which occurs rarely; and Tetrataxis sp. which occurs commonly. This unit also possesses an abundance of oolitic structures at many locations which leads one to the erroneous belief that it has an abundant microfauna.

Speiser Shale (Persistent Limestone near the Top). This unit is discussed at length in a later part of this report.

Threemile Limestone Member of the Wreford Limestone. The ostracode fauna of this unit is composed of Bairdia beedei, B. s eminalis, and Monoceratina lewisi, all of which occur rarely. This is the first appearance of Monoceratina lewisi which is found in only one stratigraphically higher limestone. The shale breaks in this unit are known to have a very abundant ostracode fauna.

Schroyer Limestone Member of the Wreford Limestone. Paraparchites humerosus is the dominant ostracode species found in this unit and occurs commonly. Bairdia beedei, B. florenaensis, and B. incisensis n. sp. occur only rarely in this unit and seem to be well distributed throughout the entire unit. B. incisensis makes its last appearance in this unit. Other microfossils found are microtrilobites, echinoid spines, and conodonts.

Kinney Limestone Member of the Matfield Shale. This unit was one of the most variable ones sampled. It varied from a commonly fossiliferous limestone to an entirely barren one. Bairdia beedei makes its final appearance in this unit in which it occurs rarely; B. verwiebei, which occurs commonly, was found only in this unit; B. reussiana occurs commonly; Sansabella bolliaformis, which occurs rarely; Hollinella emaciata occurs rarely; Knightina binodata n. sp., which occurs rarely and was found only in this unit. Other microfossils found were low-spired gastropods, and arenaceous foraminifers.

Florence Limestone Member of the Barneston Limestone. This unit is represented by a very meager ostracode fauna. The species found are: Bairdia florenaensis which occurs rarely and makes its final appearance in this limestone; Hollinella crassamarginata which made its only appearance and is represented by but two specimens in my collection; Monoceratina lewisi, which occurs rarely and makes its final appearance in the Wolfcamp series. Other microfossils were trilobite fragments, bryozans, echinoid spines, and brachiopod spines.

Fort Riley Limestone Member of the Barneston Limestone. The ostracode fauna of this unit, although not good, is superior to other units above the Wreford limestone both in the abundance and diversity of forms. The ostracodes species of this unit are: Bairdia reussiana, which is rare and makes its final appearance; Cavellina edmistonae occurs rarely; Hollinella emaciata, which occurs rarely; H. nevensis occurs commonly and makes its last appearance; Paraparchites humerosus makes its last appearance in this unit in which it occurs rarely; and Sansabella bolliaformis tumida occurs abundantly and makes its last appearance in this unit.

Towanda Limestone Member of the Doyle Shale. The ostracode f auna of this unit c onsists entirely of Hollinella emaciata which occurs only rarely and is its last appearance in rocks of the Wolfcamp series. Other microfossils in this unit are brachiopod spines, echinoid spines, high-spired gastropods, and ammodiscid-type foraminifers.

Cresswell Limestone Member of the Winfield Limestone. Hollinella sp. was found in this unit but it was so poorly preserved that a specific identification could not be made. Echinoid spines, brachiopod spines, crinoid fragments, and Polytaxis ? sp. occur commonly in this unit.

Krider Limestone Member of the Nolans Limestone. This unit was devoid of all material of organic origin. This was the only unit covered of which this is true.

Herington Limestone Member of the Nolans Limestone. This limestone, although barren of ostracodes, contained an abundance of high-spired gastropods and micro-pelecypods. Associated with these two groups were echinoid spines, holothurian ossicles, and oolitic structures which had the appearance of badly weathered ostracodes.

Other Microfossils

The microfauna of the limestones of the Wolfcamp series is predominantly an ostracode microfauna, but various other microfossils do occur commonly in the rocks covered by this investigation.

Foraminifers are entirely secondary to the ostracodes in rocks of Wolfcampian age. The forams found in these rocks are not only less abundant but are also very depauperate forms. The ones found most commonly are: Globivalvulina sp., which occurs rarely in the Beattie limestone and the Funston limestone; Tetrataxis sp. occurs rarely in almost all of the units covered in this investigation; Polytaxis sp. occurs commonly in the Funston limestone; Hyperminoids ? sp. was found commonly in the Falls City limestone and rarely in the Five Point limestone; Nodosinella sp. was encountered only in the Cottonwood limestone member of the Beattie limestone; fusulinids occur commonly in the Foraker limestone and Beattie limestone and rarely in many other units below the Barneston limestone.

The spines of echinoids and brachiopods are found throughout the Wolfcamp series; the echinoid spines are probably various species of *Echinocrinus* because it is the dominant echinoid found in rocks of this age. The brachiopod spines are beyond identification because so many genera do occur. The small silicified brachiopods found in the Falls City limestone are here referred to *Squamularia sp.* This immature brachiopod could be of value in subsurface correlation if it were found to be widespread in this unit because it was not found in other units covered by this investigation.

The bryozoans found were *Rhombopora sp.*, *Septopora sp.*, and *Polypora sp.* Although found commonly, there are of little value because they are such long-ranging forms.

The high and low-spired gastropods are one of the most common groups of microfossils found in the rocks of this age and do show some diversity but the literature on micro-gastropods is so incomplete that identification of them is impossible. In the opinion of this worker, the gastropods in the upper part of the Chase group could be used to avail because they do occur commonly.

The pygidium of trilobites are found rarely in the Wreford limestone and the Speiser shale and, although an accurate identification could not be made, they are provisionally referred to *Ditomopyge sp.*

Conclusions

In the summation of all of the information compiled during this investigation, three facts are especially noteworthy: (1) the relative abundance and distribution of the recoverable ostracodes in the limestones; (2) the very rare occurence of Kirkbyan ostracodes in the limestones of Wolfcampian age; (3) and the occurrence of ostracode species which have previously been associated with fresh-water deposits.

Considering these points in turn, the abundance of recoverable ostracodes appears to be the least significant. On the contrary, it is the most important because, as shown in the table of occurrences, (Table 1) the ostracodes do occur in sufficient abundance and distribution in the limestone to warrant additional study. Further study would undoubtedly reveal additional species that were not found in this comprehensive study of the Wolfcamp series. The proposal of the three new species in this report is not its major contribution, but it does give indication that species not previously found in shales do occur commonly in limestones. The additional information gained from study of the limestones combined with data from the shales could be used, if handled with care, for additional refinement in subsurface correlation.

The second point indicates that the Kirkbyan ostracodes are conspicuously absent from almost every limestone covered in this investigation. This proved to be one of the most interesting and perplexing problems encountered. The absence of those forms indicates a definite faunal change between the limestones and the shales. For example, in the Cottonwood limestone member at its contact with the Florena shale member, the faunal change is very prominent, because in the basal part of the Florena the Kirkbyan ostracodes occur abundatly but in the immediately underlying Cottonwood these forms are entirely absent. The same condition exists in the Barneston limestone at the contact of the Fort Riley limestone member and the Oketo shale member, and is actually even more noticeable here because the Kirkbyan forms are more abundant and diversified in the Oketo shale member than in other units of the Wolfcamp series.

This faunal change indicates the Kirkbyan ostracodes lived in the waters that were more heavily laden with clastic sediments and possibly waters that were actually muddy. It seems, too, that these forms did not move into deeper waters and certainly avoided migration into waters where large amounts of calcium carbonate were being precipitated.

Other paleoecological aspects could be postulated but there is little foundation for them until further intensive study has been completed. For example, it could be assumed that the Kirkbyan ostracodes were botton dwellers feeding primarily on detrital material along the coast line. The basis for such a conclusion is indicated by contemporary ostracodes living along most of the coastal areas of the Earth today. There seems to be corroboration for this interpretation because it is known that open-sea and deep-water forms secrete a much thinner carapace than those living close to the coast line, and the Kirkbyan ostracodes have a relatively thick carapace.

The only limestones covered in this investigation which possessed the Kirkbyan ostracodes were the Cottonwood limestone member of the Beattie limestone, in which only one specimen was found, and the Kinney limestone member of the Matfield shale in which Knightina binodata n. sp. occurs rarely. The Kinney member at the location where this species was found is very shaley which could account for the presence of this representative of the Family Kirkbyidae in this limestone. There is also the remote possibility that this species is a transitional form because, as stated in the section on systematic description, this species possesses surface ornamentation which is different from the characteristic Kirkbyan pattern and, as mentioned above, some of the specimens show an absence of the reticulated surface in some areas of the carapace.

The third point, that of the occurrence of fresh-water species, is probably the least significant but poses the most interesting aspect developed in this investigation. The dominant ostracodes found in the persistent limestone near the top of the Speiser shale are the most unusual specimens found in rocks of Wolfcampian age and, except for two very poor specimens found in the Falls City limestone, occur in no other unit covered in this investigation. Forms identical to these have been previously referred to the genus Whipplella Holland. This genus was later studied by Scott (43) who referred five of Holland's species to the following genera: Cypridopsis Brady, Candona Baird, and Gutschickia Scott. Later Cooper (9) studied the holotype and topotype specimens and referred seven species proposed by Holland

(24) and Scott (43) to the genus Carbonita Strand. The basis used by Cooper seemed to be the logical one because Jones and Kirkby (32), some years before, had prepared adequate descriptions and illustrations of specimens taken from the Coal Measures of England which were identical to the American specimens. After checking Jones and Kirkby's report, I feel the decision made by Cooper was the correct one.

The main point of interest to this worker is the fact that Holland, Scott and Cooper believe Carbonita and related genera are indicative of fresh-water limestones which, from data obtained in this investigation, could or could not be true depending upon the criterian one chooses to use. On the basis of the samples collected from the limestone in the Speiser shale at the two localities, one would be tempted to follow the conclusions of the workers cited above because Carbonita is the only genus found. However, other samples taken from the same unit, at different localities, contained specimens of six different genera. The g enera, other than Carbonita, found were Paraparchites Ulrich and Bassler, Sansabella Roundy, Coryella Harris and Lalicker, Cavellina Coryell, and Hollinella Coryell. All the genera mentioned here and associated with Carbonita have been considered to be of marine origin. If Carbonita and similar genera are of fresh-water origin why should they be associated with marine forms? The answer, in the opinion of this worker, is that Carbonita and related genera are not marine or fresh-water forms but are transitional between the two and lived in environments that were flushed with marine and fresh water. Bodies of water such as estuaries or lagoons would be typical sites for such an environment.

Another fact which is of interest is that of the faunal change which takes place within the same persistent limestone near the top of the Speiser shale. In the northern part of Riley County the microfauna in this unit consists of two genera: Carbonita, which is the abundant form, and Paraparchites Ulrich and Bassler, which is notably less abundant. This distribution of genera might indicate the direction from which the fresh water was coming. If Carbonita was a brackish-water form it would undoubtedly be found near the source of fresh-water which would not be true for the dominantly marine forms.

The occurrence of Paraparchites in the same area raises the question of the occurrence of this form in a dominantly brackish environment. The answer to this is more perplexing because this genus has been assumed to be of marine origin, but it is possible that this genus was one which could withstand a marked change in environment. This fact would be borne out by its persistent occurrence in many limestones covered in this investigation which show considerable differences in lithology.

The above conclusions can only be provisional and must be substantiated by the accummulation of additional data considered to be outside the scope of this investigation.

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OSTRACODA OF THE LIMESTONES OF THE PERMIAN
SYSTEM WOLFCAMP SERIES IN KANSAS

by

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AN ABSTRACT OF A THESIS

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This investigation was undertaken to obtain data on the ostracode microfauna of the limestones of the Wolfcamp series in Kansas. Previous studies of ostracode microfaunas have been of beds of shale with only scattered sampling of the limestones; therefore, it is believed this investigation will be a contribution to the micropaleontology of the Permian system.

The sparsity of information on the preparation of limestones for micropaleontological study necessitated trying various techniques to determine which would be the most useful in recovering ostracodes. The most useful technique proved to be careful crushing of the limestone in a steel mortar.

The limestones covered in this study yielded thirty identifiable species, two of which are proposed as new species and one specimen of a genus not heretofore described from rocks of Permian age.

The summation of all data revealed three distinctive aspects; (1) the distribution and abundance of the ostracodes is such as to be useful in the stratigraphic correlation of limestones and to warrant future study; (2) a definite faunal change between the limestones and shales was revealed by the conspicuous absence of most of the Kirkbyan forms which occur so abundantly in the shales; (3) the occurrence of ostracode species, which have been considered to be of fresh water origin, with typical marine forms.