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

By ALFRED R. LOEBLICH, JR[1]., AND HELEN TAPPAN

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1. United States National Museum. Published permission of the Secretary of the Smithsonian Institution. Arrangement of names of authors is alphabetical.

ILLUSTRATIONS

ABSTRACT

Twenty-seven species of Foraminifera, of which eleven are new, are figured and described from the Lower Cretaceous Kiowa formation from the type area in southern Kansas. Methods of study are described, evidence is presented to suggest a brackish water, near-shore origin for the Kiowa shale, and the fauna is compared to that of the black shale facies of the Kiamichi formation in northern Texas and southern Oklahoma.

INTRODUCTION

During the past ninety years numerous reports have been published of investigations concerning Lower Cretaceous Foraminifera of the Texas-Oklahoma region (ALEXANDER & SMITH, 1932, ALBRITTON, 1937, BARKER, 1944, CARSEY, 1926, CUSHMAN, 1936, 1937, 1937a, CUSHMAN & ALEXANDER, 1929, 1930, CONRAD, 1857, IKINS & CLABAUGH, 1940, KEIJZER, 1942, LALICKER, 1935, LOZO, 1943, 1944, LOEBLICH & TAPPAN, 1941, 1946, PLUMMER, 1931, 1931a, SAMPLE, 1932, TAPPAN, 1940, 1943, VANDERPOOL, 1932, and VIEAUX, 1941), but to date there is no published record of any foraminiferal assemblage in the isolated outcrops to the north and west. In the spring of 1946 the writers decided to extend their Lower Cretaceous studies to embrace this hitherto neglected area.

SCOPE OF PRESENT PAPER

The term Kiowa shale, as used in this paper, is that presented by LATTA (1946, p. 244) and includes all strata above the Cheyenne sandstone and below the Dakota formation.

Three stratigraphic sections of the Kiowa shale in the Belvidere area of Kiowa County, Kansas, were sampled for Foraminifera. The shaly beds of the subjacent Cheyenne sandstone and the "Kirby Clay" member of the overlying Dakota(?) formation were also examined for Foraminifera. The three sections presented below include most if not all of the variations of lithology in the type area of the Kiowa.

STRATIGRAPHIC SECTIONS

Locality HTL-245—In a draw in the SE ¼ Sec. 9, T. 30 S., R. 16 W., Kiowa County, Kansas. Collected May 17, 1946 by BRUCE F. LATTA and ALFRED R. LOEBLICH, JR. Section measured by BRUCE F. LATTA.

Kiowa Shale	Thickness in feet
13. Shale (covered). *Sample 871*	15
12. Shell-limestone, hard, gray and brown	0.3
11. Clay shale, blocky, black, containing thin beds of buff to tan, fine-grained sandstone. *Sample 870*	10.8
10. Shell-limestone, hard, gray to brown	0.2
9. Shale, thinly laminated, black, containing irregular yellow and brown streaks. *Sample 869* upper one-half of bed. *Sample 868* lower one-half.	11.0
8. Sandstone, fine-grained, buff to tan	0.1
7. Shale, thinly laminated, black. *Samples 865 866* and *867* each comprising about one-third of the bed, in ascending order.	23.0
6. Sandstone, fine-grained, white. *Sample 864*	0.2
5. Shell-limestone, weathered, red-brown, containing crystals of selenite, fossils poorly preserved (Champion shell bed)	0.8
Cheyenne sandstone	
4. Clay shale, lensing, dark gray, contains crystals of selenite. *Sample 872* from top three feet of the bed	6.0
3. Sandstone, fine to medium-grained, cross-bedded, massive, gray, white, tan, buff, red and purple. Contains white conglomeratic zones of pebbles of quartz and chert in lower part.	39.0
2. Shale, fissile, light-gray	3.3
Whitehorse sandstone (Permian)	
1. Sandstone, fine-grained, and shale, sandy, brick red.	

Locality HTL-246—Along the south bluff of the Medicine Lodge River, in the East one-half of Sec. 16, T. 30 S., R. 17 W., Kiowa County, Kansas. Collected May 17, 1946 by BRUCE F. LATTA and ALFRED R. LOEBLICH, JR. Section measured by BRUCE F. LATTA, CLAUDE W. HIBBARD, and JOHN C. FRYE.

Dakota formation(?)	Thickness in feet
16. Sandstone, hard, dark-brown	2.0
15. Clay shale, tan to gray	5.0
Kiowa Shale	
14. Sandstone, fine-grained, cross-bedded, tan to buff	5.2
13. Shale (covered)	20.8
12. Shale, fissile, black, containing crystals of selenite	31.2
11. Shale, gray to black, containing thin bed of tan to buff sandstone near top, mostly covered. *Sample 878*	15.6
10. Shell-limestone, gray. *Sample 877*	0.2
9. Shale, blue-black to tan, contains beds of thinly laminated sandstone and crystals of selenite. *Sample 876a* from upper portion of bed 9	21.2
8. Aragonite(?), fibrous, having cone-in-cone structure	0.2
7. Shale, thinly-bedded, gray to tan. *Sample 876* from bed 7 and lower part of bed 9	2.5
6. Shell-limestone, gray	0.8
5. Shale, fissile, black to dark gray. *Sample 875* from just below bed 6	5.2
4. Shell-limestone, gray	0.4
3. Shale, fissile, black, containing thin beds of gray to tan shale	15.6
2. Shell-limestone, gray	0.9
1. Shale, fissile, black. *Sample 873* is from upper part of bed 1 and lower unconsolidated portion of bed 2	2.5

Locality HTL-247—In Spring Draw, in the SE ¼ Sec. 4, and E. ½ Sec. 3, T. 30 S., R. 18 W., Kiowa County, Kansas. Collected May 17, 1946, by BRUCE F. LATTA and ALFRED R. LOEBLICH, JR. Section measured by BRUCE F. LATTA, CLAUDE W. HIBBARD and JOHN C. FRYE.

Dakota formation ("Reeder sandstone")	Thickness in feet
7. Sandstone, iron-cemented, hard, massive, dark-brown	10.0
6. Sand, loose, fine to medium, tan and brown	12.0
("Kirby clay")	
5. Clay, mottled red and gray, and shale, silty, red and light gray; containing thin seams of yellow, fine-grained sandstone in lower part. Mottled clay contains small red concretions of iron that have weathered out and cover the outcrop. *Sample 879* is from the lower part of the bed.	20.0

Kiowa shale
("Greenleaf sandstone")
4. Sandstone, fine-grained, cross-bedded and lensing, yellow, tan and buff. 29.0
("Spring Creek clay")
3. Clay shale, silty, mottled gray-tan, red and red-brown, containing small concretions and thin beds of ironstone, weathered slope is strewn with red-brown ironstone rubble. *Sample 880* is from the upper part of the bed. *Sample 882* is from throughout the bed. 11.0
2. Sandstone, iron-cemented, silty, irregularly bedded, red-brown to gray-tan, contains concretions, nodules and wavy bands of ironstones, weathers to a brownish black 1.7
1. Clay shale, silty, massive to thin-bedded, mottled, gray, red, and red-brown, containing cincretions of iron. Grades laterally into blue-gray siltstone and shale that contain beds and lenses of light-gray, fine-grained sandstone. Contains fish bones and pyritic gastropods. 17.8

METHODS OF STUDY

Channel samples were collected in the field by BRUCE F. LATTA and ALFRED R. LOEBLICH, JR., washed in the laboratory, and boiled in water to which soda ash had been added, then washed with a spray over a 200-mesh screen. Black shales of the Kiowa type often require several days boiling before they are perfectly clean. After drying, the samples were sieved through screens of mesh sizes 10, 20, 40, 60, 100 and 140. Material remaining on the 10-, 20- and 40-mesh screens was sorted at a magnification of 20 diameters, that on the 60-, 100-, and 140-mesh screens with a × 40 magnification and the concentrate remaining on the pan was examined at × 80 magnification.

According to NUTTALL (1934, p. 270), "It is generally found that the residue passing through the 100- or 150-mesh sieve is devoid of Foraminifera." The writers, however, have found that failure to examine the finest concentrates in the American Lower Cretaceous deposits can account for missing at least 40 species, among which are some of the most diagnostic forms in the fauna. Many of the Kiowa species pass through a 140-mesh screen and unless the concentrate is studied under adequate magnification these minute forms are overlooked.

Illustrations are shaded camera-lucida drawings by HELEN TAPPAN LOEBLICH, originally made at twice the present magnification and reduced one-half in reproduction.

All types and figured specimens are deposited in the United States National Museum, Washington, D. C. A set of unfigured paratypes and representative specimens is deposited at the University of Kansas, Lawrence, Kansas.

ACKNOWLEDGMENTS

The writers are indebted to R. C. MOORE for his interest in this problem and for making arrangements for the field work, which was financed by the Kansas Geological Survey. To B. F. LATTA we are indebted for guidance in the field and assistance in collecting samples. His knowledge of the area was of inestimable value in the stratigraphic work.

BIOSTRATIGRAPHY

COMPOSITION OF THE KIOWA FAUNA AND ITS ECOLOGICAL INTERPRETATION

The micro-faunal assemblage of the Kiowa shale is dominated by arenaceous Foraminifera. Although only 14 of the 27 species recorded from the Kiowa are arenaceous forms, specimens of these are relatively so numerous as to mask almost completely the rarer calcareous species. These arenaceous species have a large ecological valence, that is, they can most easily adapt themselves to variable or unfavorable conditions, and are found in all types of environments.

The factors which limit the distribution of species are those most subject to variation. It is unlikely that in the shallow water environment suggested by the sands and shales of the Kansas Lower Cretaceous, light or oxygen was lacking. In this area, which geographically is not far from the fossiliferous Lower Cretaceous of Texas and Oklahoma, it is unlikely also that much difference in temperature prevailed. The factor most likely to have limited the fauna thus seems to be salinity and the near-shore lithologic character of the Kiowa deposits agrees with the interpretation. As any ecologic factor approaches a limiting value, the number of species present is reduced and such conditions are indicated by some of the samples studied in which the fauna is very small. Samples from the "Kirby clay" member of the Dakota (?) formation above the Kiowa beds were found to be completely barren, as were those from the Cheyenne sandstone.

When only one or two adverse conditions exist (such as presumed low salinity of waters in which the Kiowa sediment was deposited), others being favorable, the few species which are adapted to the environment may become very numerous in individuals because of lessened competition. Thus, a brackish water fauna is characterized by few species which commonly are small in size but represented by enormous numbers of individuals, as shown by *Ammobaculites, Trochammina,* and other arenaceous foraminifers of the Kiowa. Although seven species of Lagenidae are found in the Kiowa, they are not dominant elements of the fauna, for each of these species is represented by a very few specimens, whereas the species of *Ammobaculites, Trochammina,* and other arenaceous forms comprise the major precentage of the fauna. Furthermore, all of the calcareous species are extremely small, while the larger species present in the Kiowa are those of arenaceous genera.

According to HESSE, ALLEE & SCHMIDT (1937,

p. 25), "The complete elimination of a species is frequently preceded by the production of stunted forms." This is well shown in the Kiowa fauna, the few calcareous species being considerably smaller than the average for genera to which they belong. A striking feature of the Kiowa assemblage is the almost complete absence of the planktonic Globigerinidae and Globorotaliidae, which commonly are typical members of Cretaceous faunas. Not only is the limited fauna suggestive of brackish water, the absence of pelagic species suggests that there could not have been an open connection to the sea, as otherwise at least some of the pelagic forms should have floated in. If these should immediately be killed by the adverse local environment, some elements would be present as part of the thanatocoenose, even though the species did not live and reproduce locally.

In summary, the foraminiferal evidence suggests that the Kansas Lower Cretaceous environment was at first nonmarine (the absence of marine fossils and presence of plant fossils in the Cheyenne sandstone attest to this), then a slight influx of marine waters allowed euryhaline species (tolerant of salinity variations) to migrate into this area from the open sea. Before the brackish waters, in which the Kiowa shale was deposited, could become sufficiently saline to permit the existence of stenohaline species, particularly the typical Cretaceous calcareous faunas, the seas again retreated and the brackish waters became too fresh to permit even the tolerant species to remain. By Dakota (?) ("Kirby clay") time, even the limited Kiowa foraminiferal fauna had disappeared.

CORRELATION OF THE KIOWA SHALE

PREVIOUS WORK

The exact age correlation of the Kiowa shale, within the Comanchean Series, has been disputed for many years. HILL (1889, p. 115) correlated the basal shell bed ("Champion") with the Fredericksburg division. CRAGIN (1890, p. 75) correlated the marine beds above the Cheyenne sandstone with the Fredericksburg.

HILL in 1895 stated that the Kiowa fauna was like that of the Washita division. However HILL, who defined both Fredericksburg and Washita, included the Kiamichi formation in the Washita group, so that his correlation of the Kiowa with Washita beds means "Kiamichi or younger," and not necessarily post-Kiamichi. Most geologists at present consider the Kiamichi as part of the Fredericksburg division.

TWENHOFEL (1924, pp. 23-45) also considered the Kiowa correlative with the Washita, although he noted Fredericksburg affinities of some of the fauna. BULLARD (1928, p. 61) considered the Kiowa equivalent to the Kiamichi (which he placed in the basal Washita), but put the Champion shell bed in the Fredericksburg division, correlating it with the Goodland limestone.

Thus the Kiowa has been variously considered as "Washita" and "Fredericksburg." Although most writers have correlated it with the Kiamichi, differences in group assignment result from varying interpretations of the Fredericksburg-Washita contact and its position in relation to the Kiamichi of northern Texas and southern Oklahoma.

EVIDENCE SUPPLIED BY THE FORAMINIFERA

The more closely environmental conditions approach limiting values for organisms, the more striking are the common characters of forms which are able to live under the adverse conditions. Thus, the restricted Kiowa fauna contains only very generalized species, mostly of arenaceous genera. The over-all appearance of the fauna is very like that of other strata which represent similar environments and because this similarity may be due to convergence of environmental factors, rather than close relationship, it makes correlation more difficult. An example of this is the striking similarity of the Kiowa foraminiferal generic assemblage and the Upper Cretaceous Pepper formation of Texas, the Alaskan Cretaceous, and subsurface Potomac beds of the Atlantic Coastal Plain, all of which seem to have been deposited in an environment more or less unfavorable to the Foraminifera.

Because of their adaptability, the species of large ecological valence such as comprise the Kiowa assemblage, may also actually last longer geologically and thus are not always as useful horizon markers as species of more limited ecologic and geologic range. Some of the Kiowa species have been recorded widely. One *Ammobaculoides* was originally described from the Upper Cretaceous Pepper formation (which is of similar lithology), and many others range throughout the Fredericksburg and Washita divisions of Texas.

Thus, some of the species are of doubtful value for correlation and others are too rare for even specific determination. Previously described forms which seem to be useful for correlation are *Neobulimina primitiva* (CUSHMAN) and *Ammobaculites subcretaceus* CUSHMAN & ALEXANDER, both originally described from the Goodland formation and also occurring in the Kiamichi; and *Dentalina debilis* (BERTHELIN), *Lingulina furcillata* BERTHELIN, *Gümbelitria harrisi* TAPPAN, *Eouvigerina laxistoma* LOEBLICH & TAPPAN, *Bulimina nannina* TAPPAN, and *Globigerina graysonensis* TAPPAN, which occur in both Fredericksburg and Washita beds of the Gulf Coastal Plain.

Although only a few species found in the Kiowa

have yet been recorded from the Kiamichi, the fauna of the black shale facies of the Kiamichi is only meagerly known at present. Lozo (1943, p. 1066) recorded 10 species of foraminifers from the Kiamichi in the Denison Dam section on Red River, and in a subsequent paper (1944, p. 565) recorded only 7 species from the Kiamichi black shale facies in north Texas. The writers have studied a large number of Kiamichi sections in northern Texas and southern Oklahoma, and although the information obtained has not yet been published, the Kiowa and Kiamichi are similar in both lithologic character and faunal content.

Some of the species here described as new are also present in our unpublished Kiamichi material. Among these are *Ammomarginulina cragini, Ammobaculites auricularis, A. euides, A. obliquus, Ammobaculoides phaulus, Verneuilinoides kansasensis* and *Pyrulina carebara.*

While many of the species in the Kiowa occur in both the Fredericksburg (Kiamichi) and Washita groups of Texas, the assemblage as a whole is not seen in beds later than the Kiamichi. The species here described as new, which occur in the Kiamichi as mentioned above, have not been seen in the Washita material which we have studied. On the basis of our foraminiferal studies, we consider the Kiowa to be correlative with the Kiamichi, and the Kiamichi to be most closely related to the underlying beds, and thus of Fredericksburg age.

In addition to the black shale assemblages of the Kiamichi, which are in part nearly identical with those of the Kiowa, there is much of the Kiamichi that is more nearly typically marine, even the dark shales in places containing a considerable variety of calcareous species in great abundance. This is to be expected as the normal marine seas were toward the south, Kiowa beds being deposited at their northernmost extension.

DESCRIPTIONS OF GENERA AND SPECIES

FAMILY SACCAMMINIDAE

SUBFAMILY SACCAMMININAE

GENUS PROTEONINA WILLIAMSON, 1858

Proteonina alexanderi, new species

Plate 1, figures 1a-2b

Test free, consisting of a single flask-shaped chamber, in some specimens compressed, apertural end extended into a neck; wall fairly thick, coarsely arenaceous; aperture terminal, rounded. Length of holotype, 0.48 mm.; greatest breadth, 0.30 mm.; length of paratype 0.76 mm.

Discussion.—This species is very similar to *Proteonina lagenaria* BERTHELIN in general appearance, but differs in being somewhat more clavate in shape and in being approximately three times as large. It differs from *P. difflugiformis* (H. B. BRADY) in being less fusiform, more coarsely arenaceous, and in possessing a less well defined neck.

Occurrence.—Comanchean Series, Lower Cretaceous. Holotype and paratypes from the Kiowa shale, Fredericksburg group, in a draw in the SE ¼, Sec. 9, T. 30 S., R. 16 W., Kiowa County, Kansas.

Types.—Holotype, U. S. National Museum No. 112539; paratype, U. S. National Museum No. 112526; unfigured paratype, University of Kansas.

FAMILY AMMODISCIDAE

SUBFAMILY AMMODISCINAE

GENUS AMMODISCUS REUSS, 1861

Ammodiscus kiowensis, new species

Plate 1, figures 3a-b.

Test free, tiny, planispiral, consisting of a minute proloculus and long undivided tubular second chamber, which increases gradually in size during the five to six coils around the proloculus, the coiling somewhat irregular in some specimens, so that the tubular chamber may overlap a previous coil for a short distance; spiral suture distinct, depressed; wall finely arenaceous, with considerable cement, surface smoothly finished; aperture formed by the open end of the tube. Greatest diameter of holotype, 0.16 mm.; least diameter, 0.15 mm.; greatest thickness, 0.06 mm.; other specimens range to 0.20 mm. in diameter.

Discussion.—This species resembles *Ammodiscus gaultinus* BERTHELIN in the somewhat irregular coiling, but differs in the greater amount of overlap of the coils and comparatively thicker coil, and the Kiowa species is about one-half as large.

Occurrence.—Comanchean Series, Lower Cretaceous. The holotype is from the Kiowa shale, Fred-

ericksburg group, along the south bluff of the Medicine Lodge River, in the east ½, Sec. 16, T. 30 S., R. 17 W., Kiowa County, Kansas. Other specimens were collected from the Kiowa shale ("Spring Creek" clay) in Spring Draw, in the SE ¼, Sec. 4, and east ½, Sec. 3, T. 30 S., R. 18 W., and in a draw in the SE ¼, Sec. 9, T. 30 S., R. 16 W., Kiowa County, Kansas.

Types.—Holotype, U. S. National Museum No. 112514; unfigured paratypes, University of Kansas.

FAMILY LITUOLIDAE

SUBFAMILY HAPLOPHRAGMIINAE

GENUS AMMOMARGINULINA WIESNER, 1931

Ammomarginulina cragini, new species

Plate 1, figures 4a-6

Test free, comparatively large, flattened; early chambers evolutely coiled, 6 to 9 in the last coil, later chambers rectilinear, commonly about two uniserial chambers; sutures nearly straight, slightly depressed, somewhat thickened, obscure except when specimen is dampened; wall arenaceous, of medium-sized grains, smoothly finished; aperture at the base of the apertural face of the last chamber in the coiled portion, terminal and elongate in the uniserial portion.

Length of holotype, 0.69 mm.; greatest breadth of coil, 0.44 mm.; thickness, 0.14 mm. Length of specimen in figure 5, 0.74 mm.; greatest breadth, 0.51 mm. Greatest diameter of specimen in figure 6, showing coiled portion only, 0.61 mm.; least diameter 0.51 mm. Other specimens range to 0.96 mm. in length.

Discussion.—This species is somewhat similar to *Ammomarginulina bellensis* LOEBLICH, from the Upper Cretaceous Pepper formation, in its flattened character and in having approximately the same number of chambers in the last whorl of the coiled portion, but differs in being twice as large and in having a much less well developed uniserial portion.

Occurrence.—Comanchean Series, Lower Cretaceous. The holotype was collected from the Kiowa shale, Fredericksburg group, in a draw in the SE ¼, Sec. 9, T. 30 S., R. 16 W., Kiowa County, Kansas. It is also recorded from the Kiowa shale along the south bluff of the Medicine Lodge River in the east ½, Sec. 16, T. 30 S., R. 17 W., Kiowa County, Kansas.

Types.—Holotype, U. S. National Museum No. 112525; paratypes, U. S. National Museum Nos. 112523 and 112524; unfigured paratypes, University of Kansas.

GENUS AMMOBACULITES CUSHMAN, 1910

Ammobaculites auricularis, new species

Plate 1, figures 12a-13

Test free, auriculate, medium in size, early portion close coiled, later uniserial, periphery subacute; chambers numerous, increasing gradually in size as added, about six in the coiled portion, up to five in the uncoiled portion; sutures very slightly curved backward at the periphery and obscure in the coiled portion, oblique, slightly depressed in the later portion; wall finely arenaceous, with a few larger grains, surface smoothly finished; aperture terminal, rounded.

Length of holotype, 0.67 mm.; greatest breadth, 0.33 mm.; greatest thickness, 0.14 mm. Length of paratype in figure 13, 0.50 mm.; greatest breadth, 0.30 mm.; greatest thickness 0.09 mm.

Discussion.—This species is somewhat similar to *Ammobaculites cassis* (PARKER) in the broad test and oblique sutures, but differs in being only one-third as large.

Occurrence.—Comanchean Series, Lower Cretaceous. The holotype and figured paratype were collected from the Kiowa shale, Fredericksburg group, in a draw in the SE ¼ Sec. 9, T. 30 S., R. 16 W., Kiowa County, Kansas. It also occurs in the Kiowa shale along the south bluff of the Medicine Lodge River in the east ½ Sec. 16, T. 30 S., R. 17 W., Kiowa County, Kansas.

Types.—Holotype, U. S. National Museum No. 112519; paratype, U. S. National Museum No. 112520; unfigured paratypes, University of Kansas.

Ammobaculites euides LOEBLICH & TAPPAN

Plate 1, figures 7-11

Ammobaculites euides LOEBLICH & TAPPAN, 1949, Jour. Washington Acad. Sci., vol. 39, p. 90. ———, LOEBLICH & TAPPAN, 1949, Jour. Paleon., vol. 23, p. 250, pl. 46, figs. 8a-b.

Test free, medium in size, early portion coiled, later uniserial, rounded in section; about four chambers in the involute coil, later portion having as many as six uniserial chambers; sutures somewhat obscure in the coil, straight and depressed in the later portion; wall finely arenaceous, surface smoothly finished; aperture terminal, rounded.

Length of holotype, 0.96 mm.; greatest breadth, 0.35 mm.; greatest thickness, 0.19 mm. Lengths of specimens, in figure 7, 0.30 mm.; in figure 8, 0.44 mm.; in figure 9, 0.55 mm.; and in figure 11, 0.83 mm.

Discussion.—A complete series can be obtained of this species, from specimens having only the

early coil to specimens showing as many as six uniserial chambers. This species differs from *Ammobaculites coprolithiformis* (SCHWAGER) in being about one-third smaller, comparison being based on specimens of equal development, and in having an initial coil of diameter greater than that of the uniserial portion. In *A. coprolithiformis*, the earliest uniserial chambers are much narrower than the coil, the test then flaring with growth, and the chambers also increasing rapidly in height as added. In *A. euides*, the initial coil is greater in diameter than the uniserial portion, which increases very little in diameter or chamber height.

Ammobaculites euides is similar to Upper Cretaceous specimens referred to *A. coprolithiformis* by CUSHMAN, but differs from these in the smaller size, in having comparatively higher chambers, and in having a much more smoothly finished wall.

Occurrence.—Comanchean Series, Lower Cretaceous. The holotype of this species was collected from the Kiowa shale, Fredericksburg group, along the south bluff of the Medicine Lodge River in the east ½ Sec. 16, T. 30 S., R. 17 W., Kiowa County, Kansas. The species is also found in the Kiowa shale ("Spring Creek" clay) from Spring Draw, in the SE ¼ Sec. 4, and east ½ Sec. 3, T. 30 S., R. 18 W., and from the draw in the SE ¼ Sec. 9, T. 30 S., R. 16 W., Kiowa County, Kansas.

Types.—Holotype, U. S. National Museum No. 112528; figured paratypes, U. S. National Museum Nos. 112527a to 112527d; unfigured paratypes, University of Kansas.

Ammobaculites obliquus LOEBLICH & TAPPAN

Plate 1, figures 14a-17

Ammobaculites obliquus LOEBLICH & TAPPAN, 1949, Jour. Washington Acad. Sci., vol. 39, p. 90. ———, LOEBLICH & TAPPAN, 1949, Jour. Paleon., vol. 23, p. 250, pl. 46, figs. 4a-5.

Test free, medium in size, early portion close-coiled, later uniserial and rounded in section; five to seven chambers in the coil, followed by three to four uniserial chambers; sutures straight and obscure in the coil, oblique and slightly depressed in the uniserial portion; wall finely arenaceous, surface smoothly finished; aperture terminal, rounded.

Length of holotype, 0.86 mm.; greatest breadth, 0.32 mm.; greatest thickness, 0.25 mm. Length of paratype in figure 17, 0.63 mm.; greatest breadth, 0.23 mm.; greatest thickness, 0.14 mm. Length of paratype in figure 15, 0.62 mm.; breadth of last chamber, 0.16 mm.; greatest thickness, 0.14 mm. Length of paratype in figure 16, 0.44 mm.; greatest breadth, 0.16 mm.

Discussion.—This species differs from *Ammobaculites coprolithiformis* (SCHWAGER) in being about half as large, in having a more compressed coil, and in possessing oblique sutures in the uniserial portion.

Occurrence.—Comanchean Series, Lower Cretaceous. The holotype is from the Kiowa shale, Fredericksburg group, along the south bluff of the Medicine Lodge River in the east ½ Sec. 16, T. 30 S., R. 17 W., Kiowa County, Kansas. It is also recorded from the Kiowa shale in the draw in the SE ¼ Sec. 9, T. 30 S., R. 16 W., and from the Kiowa shale ("Spring Creek" clay) in Spring Draw, in the SE ¼ Sec. 4, and east ½ Sec. 3, T. 30 S., R. 18 W., Kiowa County, Kansas.

Types.—Holotype, U. S. National Museum No. 112522; figured paratypes, U. S. National Museum Nos. 112521a to 112521c; unfigured paratypes, University of Kansas.

Ammobaculites subcretaceus CUSHMAN & ALEXANDER

Plate 1, figures 21a-22

Ammobaculites subcretacea CUSHMAN & ALEXANDER, 1930, Contr. Cushman Lab. Foram. Res., vol. 6, p. 6, pl. 2, figs. 9-10.
Ammobaculites subcretaceus CUSHMAN & ALEXANDER, LOZO, 1944, Amer. Mi. Nat., vol. 31, p. 538, pl. 4, figs. 2-3.

Test free, medium in size, flattened; early chambers close-coiled, seven to eight in the coil, test slightly depressed in the umbilical region, later chambers rectilinear, as many as four uniserial chambers; sutures straight, obscure in the coiled portion, very slightly depressed in the uniserial portion; wall arenaceous, composed of medium to coarse grains, with rough exterior; aperture terminal in the uniserial portion.

Length of hypotype in figure 22, 0.78 mm.; greatest breadth, 0.35 mm. Length of hypotype in figure 21, 0.92 mm.; greatest breadth of coil, 0.35 mm.; greatest thickness, 0.14 mm.; greatest breadth of uniserial portion, 0.30 mm.

Discussion.—This species has been recorded by CUSHMAN (1946a, p. 23) from the Upper Cretaceous Eagle Ford formation, but CUSHMAN's figures seem to differ from the Lower Cretaceous forms in having broader coils as compared to the uniserial portions. Specimens figured by ALBRITTON (1937, pl. 4, figs. 3-4) from the Torcer formation seem not to be identical with the Fredericksburg specimens. The writers have not recognized this species above the Kiamichi of Texas and Oklahoma.

Occurrence.—Comanchean Series, Lower Cretaceous. The figured hypotypes were collected from the Kiowa shale, Fredericksburg group, from the south bluff of the Medicine Lodge River in the E½, Sec. 16, T. 30 S., R. 17 W. and from a draw in the SE¼ Sec. 9, T. 30 S., R. 16 W., Kiowa County, Kansas.

Types.—Figured hypotypes, U. S. National Museum Nos. 112518a and 112518b; unfigured hypotype, University of Kansas.

GENUS **AMMOBACULOIDES** PLUMMER, 1932

Ammobaculoides phaulus, new species

Plate 1, figures 18a-20

Test free, tiny, flattened, early portion close-coiled, later biserial, the final chambers tending to become uniserial; 6 to 7 chambers in the last whorl of the coil, followed by 4 to 5 biserial chambers, the last chamber generally becoming terminal; sutures distinct, somewhat more clear than the remainder of the test, straight in the coil, becoming slightly curved and somewhat depressed in the later portion of the test; wall finely arenaceous, surface smoothly finished; aperture at the base of the last chamber in the early portion, becoming terminal on the last chamber.

Length of holotype, 0.30 mm.; greatest breadth, 0.12 mm.; greatest thickness, 0.07 mm. Length of paratype in figure 20, 0.30 mm.; greatest breadth of coil, 0.14 mm. Length of paratype in figure 19, 0.29 mm.; greatest breadth of coil, 0.09 mm.

Discussion.—This species is similar in general appearance to *Ammobaculoides gainsvillensis* LOEBLICH & TAPPAN from the Denton, Weno, and Paw Paw formations, but differs in being about one-half as large, comparatively narrower, and in having a less well-developed uniserial portion.

Occurrence.—Comanchean Series, Lower Cretaceous. The holotype and figured paratypes were collected from the Kiowa shale, Fredericksburg group, along the south bluff of the Medicine Lodge River in the E½, Sec. 16, T. 30 S., R. 17 W., Kiowa County, Kansas. It is also recorded from the Kiowa shale in the draw in the SE¼, Sec. 9, T. 30 S., R. 16 W. and from Spring Draw in the SE¼, Sec. 4, and E½, Sec. 3, T. 30 S., R. 18 W., Kiowa County, Kansas.

Types.—Holotype, U. S. National Museum No. 112531; figured paratypes, U. S. National Museum 112532 and 112532b; unfigured paratypes, University of Kansas and Helen Jeanne Plummer Collection, Austin, Texas.

EXPLANATION OF PLATE 1

FIGURES — PAGE

1a-2b.—Proteonina alexanderi, n. sp. *1a,* Side view of paratype (U. S. National Museum 112526); *1b,* top view showing compression due to preservation. *2a,* Side view of holotype (U. S. National Museum 112539); *2b,* top view of holotype. All × 36..... 5

3a-b.—Ammodiscus kiowensis, n. sp. *3a,* Side view of holotype (U. S. National Museum 112514); *3b,* edge view. × 109..... 5

4a-6.—Ammomarginulina cragini, n. sp. *4a,* Side view of holotype (U. S. National Museum 112525); *4b,* top view. *5,* Side view of paratype (U. S. National Museum 112524). *6,* Side view of paraytpe (U. S. National Museum 112523) which has not developed the uniserial portion. All × 36..... 6

7-11.—Ammobaculites euides LOEBLICH & TAPPAN. *7,* Side view of young paratype (U. S. National Museum 112527c) showing only the early coil. *8,* Side view of paratype (U. S. National Museum 112527d) showing early development of the uniserial portion. *9,* Side view of somewhat better developed paratype (U. S. National Museum 112527b). *10a,* Side view of holotype (U. S. National Museum 112528) showing well developed uniserial portion; *10b,* top view. *11,* Side view of paratype (U. S. National Museum 112527a). All × 36.... 6

12a-13.—Ammobaculites auricularis, n. sp. *12a,* Side view of holotype (U. S. National Museum 112519); *12b,* top view. *13,* Side view of paratype (U. S. National Museum 112520). All × 48..... 6

14a-17.—Ammobaculites obliquus LOEBLICH & TAPPAN. *14a,* Side view of holotype (U. S. National Museum 112522); *14b,* top view, × 36. *15a,* Side view of partype (U. S. National Museum 112521c); *15b,* top view, × 48. *16,* Side view of partype (U. S. National Museum 112521a), × 48. *17,* Side view of paratype (U. S. National Museum 112521b), × 36 7

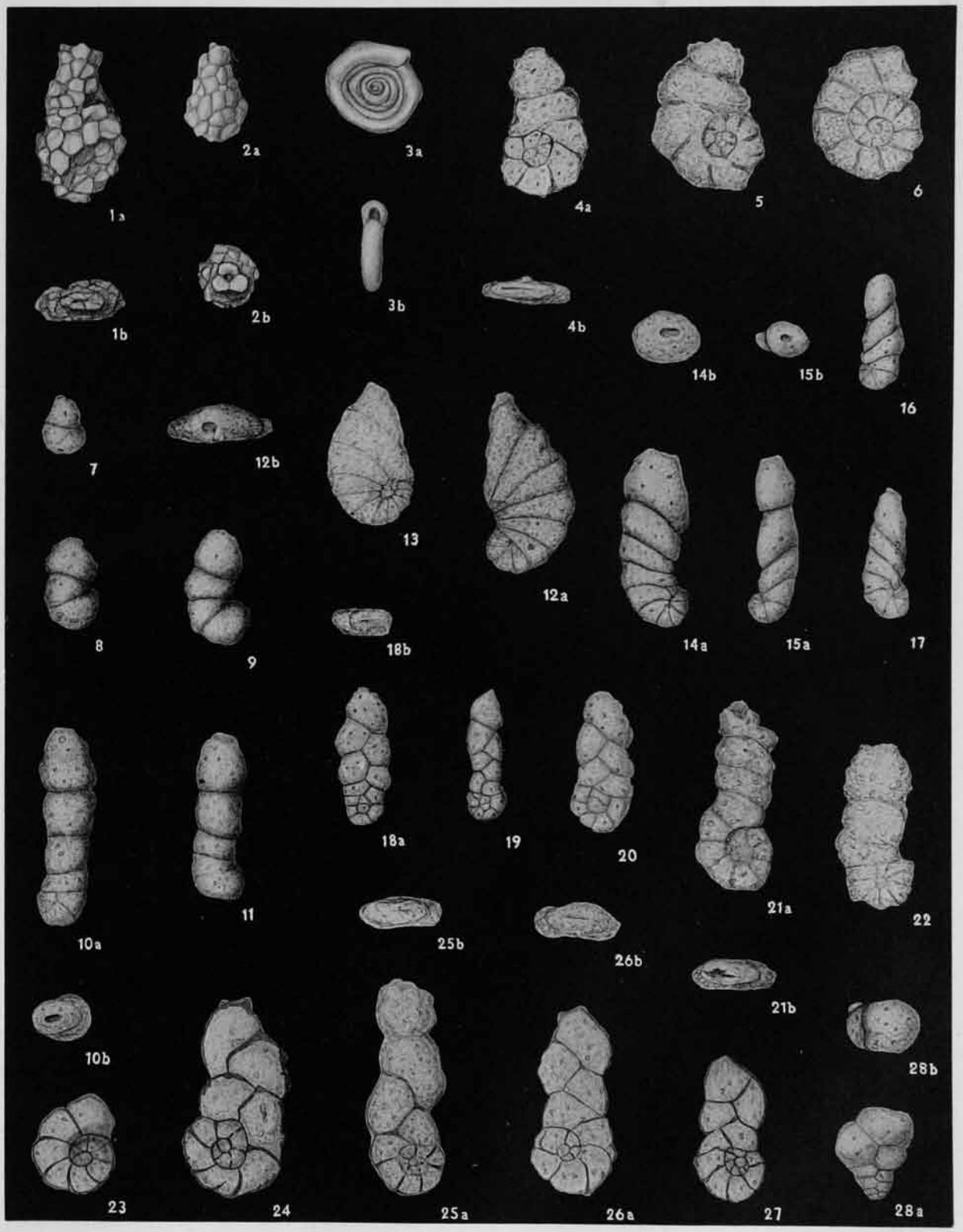
18a-20.—Ammobaculoides phaulus, n. sp. *18a,* Side view of holotype (U. S. National Museum 112531); *18b,* top view. *19,* Side view of paratype (U. S. National Museum 112532a). *20,* Side view of paratype (U. S. National Museum 112532b). All × 79.... 8

21a-22.—Ammobaculites subcretaceus CUSHMAN & ALEXANDER. *21a,* Side view of hypotype (U. S. National Museum 112518a); *21b,* top view. *22,* Side view of hypotype (U. S. National Museum 112518b). *22,* Side view of hypotype (U. S. National Museum 112518b). All × 36..... 7

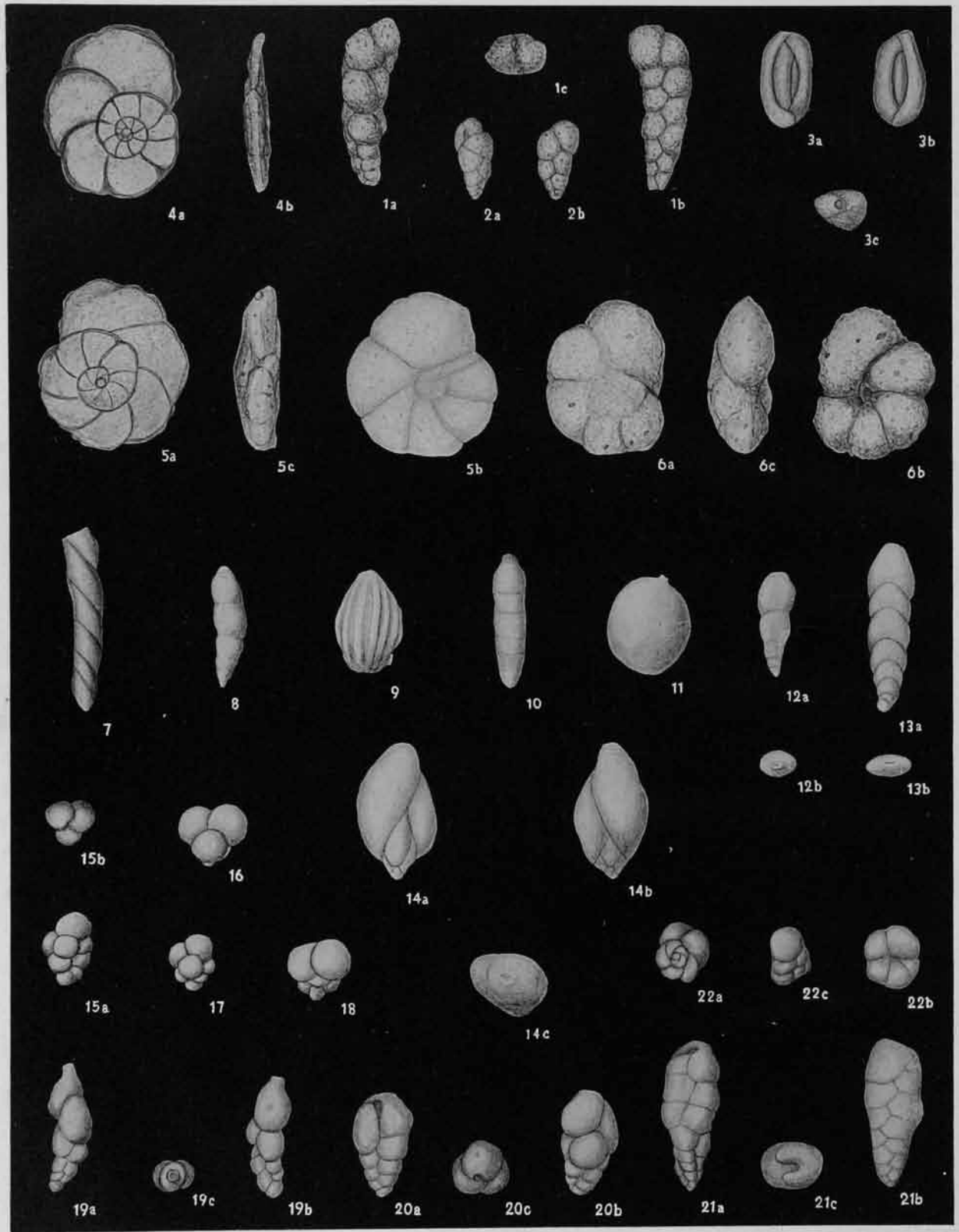
23.—Trochammina callima, n. sp. Side view of paratype (U. S. National Museum 112516b) to show the similarity of this species to the coiled portion of *Ammobaculoides plummerae* LOEBLICH, from which it differs in the trochoid character. × 79. 10

24-27.—Ammobaculoides plummerae LOEBLICH. *24,* Side view of hypotype (U. S. National Museum 112509c). *25a,* Side view of hypotype (U. S. National Museum 112509b); *25b,* top view. *26a,* Side view of hypotype (U. S. National Museum 112509a); *26b,* top view. *27,* Side view of hypotype (U. S. National Museum 112509d). All × 79..... 9

28a-b.—Textularia sp. *28a,* Side view; *28b,* top view (U. S. National Museum 112507). × 109.. 9



Loeblich & Tappan—Lower Cretaceous Foraminifera



Loeblich & Tappan—Lower Cretaceous Foraminifera

Ammobaculoides plummerae LOEBLICH

Plate 1, figures 24-27

Ammobaculoides plummerae LOEBLICH, 1946, Jour. Paleon., vol. 20, p. 137-138, pl. 22, figs. 10-12b; text figs. 3a-g.

Test free, tiny, flattened, early portion evolutely coiled, with 1½ to 2 whorls, later biserial, with final chambers uniserial; chambers increasing gradually in size as added, about 6 to 7 in the final whorl of the coil, which is followed by 2 to 4 biserially arranged chambers, then one or two uniserial chambers; sutures slightly depressed, nearly straight or very slightly arched; wall finely arenaceous, surface smoothly finished; aperture terminal, somewhat elongate.

Length of hypotype in figure 25, 0.46 mm.; greatest breadth of coiled portion, 0.16 mm.; greatest thickness, 0.07 mm. Length of hypotype in figure 24, 0.44 mm.; breadth of coil, 0.23 mm.; greatest thickness, 0.08 mm. Length of hypotype in figure 27, 0.32 mm.; greatest breadth of coil, 0.16 mm. Length of hypotype in figure 26, 0.42 mm.; greatest breadth of coil, 0.20 mm.; greatest thickness, 0.09 mm.

Discussion.—This species was first described from the Upper Cretaceous Pepper formation, but specimens from the Kiowa cannot be distinguished from the Pepper types and hence, in spite of their wide stratigraphic separation, are referred to this species.

Occurrence.—Comanchean Series, Lower Cretaceous. Hypotypes of this species have been recorded from the Kiowa shale, Fredericksburg group, from the draw in the SE¼, Sec. 9, T. 30 S., R. 16 W., and from along the south bluff of the Medicine Lodge River in the E½, Sec. 16, T. 30 S., R. 17 W., Kiowa County, Kansas.

Types.—Figured hypotypes, U. S. National Museum Nos. 112509a to 112509d; unfigured hypotypes, University of Kansas.

FAMILY TEXTULARIIDAE

SUBFAMILY TEXTULARIINAE

GENUS TEXTULARIA DEFRANCE, 1824

Textularia sp.

Plate 1, figures 28a-b

Test free, minute, subconical; chambers biserially arranged, increasing gradually in size as added; sutures distinct, depressed, straight; wall very finely arenaceous, surface smoothly finished; aperture an arch at the base of the apertural face of the last chamber.

Length of figured specimen, 0.15 mm.; greatest breadth, 0.13 mm.; greatest thickness, 0.09 mm.

EXPLANATION OF PLATE 2

Discussion.—Specimens from the Kiowa are similar to *Textularia chapmani* LALICKER from the Gault of Folkestone, England, but are approximately one-half the size. As the specimens are extremely rare in the Kiowa, they may be juveniles and thus we have not attempted to identify them specifically. The Kiowa specimens differ from *T. rioensis* CARSEY of the Washita in having a subquadrate rather than circular cross-section and in being much smaller.

Occurrence.—Comanchean Series, Lower Cretaceous. Specimens of this form are recorded from the Kiowa shale, Fredericksburg group, along the south bluff of the Medicine Lodge River in the E½, Sec. 16, T. 30 S., R. 17 W., Kiowa County, Kansas.

Types.—Figured specimen, U. S. National Museum 112507; unfigured specimen, University of Kansas.

FAMILY VERNEUILINIDAE

GENUS VERNEUILINOIDES LOEBLICH & TAPPAN, 1949

Verneuilinoides kansasensis, new species

Plate 2, figures 1a-2b

Test free, tiny, elongate, triserial, the angles rounded; chambers increasing gradually in size, early chambers low, later chambers equal in height and breadth; sutures distinct, depressed; wall finely arenaceous, surface smoothly finished; aperture a low arch at the base of the final chamber.

Length of holotype, 0.37 mm.; greatest breadth, 0.12 mm.; greatest thickness, 0.09 mm. Length of paratype, 0.16 mm.; greatest breadth, 0.08 mm.; greatest thickness, 0.07 mm.

Discussion.—This species is somewhat similar in general appearance to *Verneuilinoides perplexa* (LOEBLICH) from the Pepper shale of Texas, but it does not flare as rapidly and possesses a more typical textularian aperture.

Occurrence.—Comanchean Series, Lower Cretaceous. Holotype and figured paratype from the Kiowa shale, Fredericksburg group, on the south bluff of the Medicine Lodge River in the E½, Sec. 16, T. 30 S., R. 17 W., Kiowa County, Kansas. It is also recorded from the Kiowa shale in the draw in the SE¼, Sec. 9, T. 30 S., R. 16 W., and from Spring Draw in the SE¼, Sec. 4, and E½, Sec. 3, T. 30 S., R. 18 W., Kiowa County, Kansas.

Types.—Holotype, U. S. National Museum No. 112512; paratype, U. S. National Museum, No. 112513; unfigured paratypes, University of Kansas.

FAMILY MILIOLIDAE

GENUS QUINQUELOCULINA D'ORBIGNY, 1826

Quinqueloculina nanna, new species

Plate 2, figures 3a-c

Test free, minute, ovate in outline, typically quinqueloculine in plan; chambers increasing regularly in size; sutures distinct, depressed; wall agglutinated, consisting of fine grains with considerable cement, surface smoothly finished; aperture terminal, rounded, no tooth visible. Length of holotype, 0.16 mm.; greatest breadth, 0.09 mm.; greatest thickness, 0.05 mm.

Discussion.—This species is similar in general appearance to *Quinqueloculina antiqua* FRANKE var. *angusta* FRANKE, from the Upper Cretaceous of Germany, but differs in being about one quarter the size, more ovate in outline rather than fusiform, in lacking the protruding neck, and in being more triangular in cross-section.

Occurrence.—Comanchean Series, Lower Cretaceous. Holotype from the Kiowa shale, Fredericksburg group, from the south bluff of the Medicine Lodge River in the E½, Sec. 16, T. 30 S., R. 17 W., Kiowa County, Kansas. Recorded also from the Kiowa shale ("Spring Creek" clay) in Spring Draw, in the SE¼, Sec. 4 and E½, Sec. 3, T. 30 S., R. 18 W., Kiowa County, Kansas.

Types.—Holotype, U. S. National Museum No. 112529; unfigured paratypes, University of Kansas.

FAMILY TROCHAMMINIDAE

SUBFAMILY TROCHAMMININAE

GENUS TROCHAMMINA PARKER & JONES, 1859

Trochammina callima, new species

Plate 1, figure 23; Plate 2, figures 4a-5c

Test free, small, trochoid, occasional specimens flattened in preservation, about 2 to 3 coils visible dorsally on fully developed specimens, only the 6 to 7 chambers of the last whorl visible ventrally; sutures depressed, straight ventrally, somewhat curved backward at the periphery on the dorsal side; wall thin, finely arenaceous, smoothly finished; aperture at the inner margin of the ventral side of the chamber.

Greatest diameter of holotype (fig. 5), 0.37 mm.; least diameter, 0.32 mm.; greatest thickness, 0.12 mm. Greatest diameter of large paratype, a crushed specimen (fig. 4), 0.35 mm.; least diameter, 0.28

mm.; greatest thickness, 0.06 mm. Greatest diameter of small paraytpe (Pl. 1, fig. 23), 0.22 mm.; least diameter, 0.19 mm.

Discussion.—This species is similar to *Trochammina depressa* Lozo from the Kiamichi formation, but is about one-third larger, much thicker, and does not have the comparatively large final chamber of *T. depressa.*

Occurrence.—Comanchean Series, Lower Cretaceous. The holotype and figured paratypes are from the Kiowa shale, Fredericksburg group, from a draw in the SE¼, Sec. 9, T. 30 S., R. 16 W., Kiowa County, Kansas. It is also recorded from the south bluff of the Medicine Lodge River in the E½, Sec. 16, T. 30 S., R. 17 W., Kiowa County, Kansas.

Types.—Holotype, U. S. National Museum No. 112515; figured paratypes, U. S. National Museum Nos. 112516a and 112516b; unfigured paratype, University of Kansas.

Trochammina lattai, new species

Plate 2, figures 6a-c

Test free, small, trochoid, convex dorsally, ventrally umbilicate, periphery rounded; five rounded chambers in the last whorl; sutures very obscure in the early portion of test, but the sutures of the last whorl are distinct and constricted so as to give a lobulate periphery, sutures nearly straight; wall finely arenaceous, with considerable cement, aperture an arched slit at the inner margin of the ventral side of the last chamber.

Greatest diameter of holotype, 0.35 mm.; least diameter, 0.25 mm.; greatest thickness, 0.14 mm.

Discussion.—This species differs from *Trochammina depressa* Lozo in being approximately one-third larger, much thicker, and in possessing a distinct ventral umbilicus.

Occurrence.—Comanchean Series, Lower Cretaceous. The holotype is recorded from the Kiowa shale, Fredericksburg group, from the draw in the SE¼, Sec. 9, T. 30 S., R. 16 W., Kiowa County, Kansas. It is also recorded from the Kiowa shale along the south bluff of the Medicine Lodge River, in the E½, Sec. 16, T. 30 S., R. 17 W., Kiowa County, Kansas.

Types.—Holotype, U. S. National Museum No. 112538; unfigured paratype, University of Kansas.

FAMILY **LAGENIDAE**

SUBFAMILY **NODOSARIINAE**

GENUS **DENTALINA** D'ORBIGNY, 1826

Dentalina debilis (Berthelin)

Plate 2, figure 7

Marginulina debilis BERTHELIN, 1880, Soc. géol. France Mém., sér. 3, t. 1, no. 5, p. 3, pl. 3 (26), fig. 28. ———, CHAPMAN, 1894, Roy. Micr. Soc. Jour., p. 161, pl. 4, fig. 15. ———, EGGER, 1910, Nat. Ver. Regensburg, Bericht., p. 109, pl. 1, fig. 16.

Dentalina debilis (BERTHELIN), EICHENBERG, 1933, Niedersächs geol. Ver. Jahresber., 25, Folge 2, p. 183, pl. 23, fig. 10; 1934, Niedersächs geol. Ver. Jahresber., 26, p. 167, pl. 12, fig. 9. ———, Lozo, 1944, Amer. Mid. Nat., vol. 31, p. 555, pl. 4, fig. 17.

Vaginulina debilis (BERTHELIN), TAPPAN, 1940, Jour. Paleon. vol. 14, pp. 108-109, pl. 16, figs. 26a-b. ———, TAPPAN, 1943, Jour. Paleon. vol. 17, p. 500, pl. 80, fig. 15.

Test free, minute, elongate, slightly arcuate, rounded in section; chambers numerous, increasing gradually in size from the pointed proloculus; sutures distinct, oblique, highest at the inner side of the arcuate test; wall calcareous, very finely perforate, surface smooth; aperture terminal, apertural end of figured specimen broken.

Length of hypotype, 0.30 mm.; breadth, 0.05 mm.

Discussion.—This is probably a juvenile specimen and does not show well all the typical specific characters, but does show the subtriangular cross-section, pointed base, and extremely oblique sutures characteristic of *Dentalina debilis* (BERTHELIN). This species has been recorded from the Goodland formation and throughout the Washita. It is extremely rare in the Kiowa.

Occurrence.—Comanchean series, Lower Cretaceous. Figured specimen from the Kiowa shale, Fredericksburg group, along the south bluff of the Medicine Lodge River, in the E½, Sec. 16, T. 30 S., R. 17 W., Kiowa County, Kansas.

Type.—Figured specimen, U. S. National Museum No. 112511.

Dentalina sp.

Plate 2, figure 8

Test free, tiny, elongate, uniserial, faintly curved; chambers increasing rapidly in size at first, then more slowly so that the last half of the test is cylindrical; sutures straight, not depressed; wall calcareous, surface smooth; aperture terminal.

Length, 0.21 mm.; greatest diameter, 0.05 mm.

Discussion.—The rarity of this species and small size of the specimens encountered has prevented us from making specific identification.

Occurrence.—Comanchean Series, Lower Cretaceous. Figured specimen from the Kiowa shale, Fredericksburg group, along the south bluff of the Medicine Lodge River in the E½, Sec. 16, T. 30 S., R. 17 W., Kiowa County, Kansas.

Types.—Figured specimen, U. S. National Museum No. 112530; unfigured specimen, University of Kansas.

GENUS **NODOSARIA** LAMARCK, 1812

Nodosaria sp.

Plate 2, figure 9

Test free, consisting of a series of ovate chambers, greatly constricted at the sutures, so that unbroken tests are extremely rare, all specimens observed consisting only of isolated chambers, showing by their

broken ends that they are only a portion of a multilocular test; wall calcareous, surface ornamented by 15 longitudinal ridges; aperture terminal.

Length of single chamber figured, 0.23 mm.; greatest diameter, 0.14 mm.

Discussion.—This species is similar to *Nodosaria oklahomensis* TAPPAN, from the Duck Creek formation, in the greatly constricted sutures and inflated chambers, but differs in having 15 ribs rather than 8 to 10. Because of its rarity and because it is represented only by fragmentary specimens, it is not here specifically identified. Fragments such as that illustrated may be mistaken easily for *Lagena sulcata* (WALKER & JACOB), but the broken appearance of both ends demonstrate its fragmentary nature.

Occurrence.—Comanchean Series, Lower Cretaceous. Figured specimen recorded from the Kiowa shale, Fredericksburg group, from the south bluff of the Medicine Lodge River, in the E½, Sec. 16, T. 30 S., R. 17 W., Kiowa County, Kansas.

Type.—Figured specimen, U. S. National Museum No. 112534.

GENUS **PSEUDOGLANDULINA** CUSHMAN, 1929

Pseudoglandulina sp.

Plate 2, figure 10

Test free, tiny, elongate, rectilinear, round in cross-section; chambers cylindrical, increasing very little in size after the first two or three chambers; sutures distinct, not depressed; wall calcareous, surface smooth; aperture terminal, radiate.

Length of figured specimen, 0.22 mm.; greatest diameter, 0.06 mm.

Discussion.—This form is quite similar in general appearance to *Pseudoglandulina manifesta* (REUSS) from the Upper Cretaceous, but is much smaller, tests of an equal number of chambers being only about one-fourth as large.

Occurrence.—Comanchean Series, Lower Cretaceous. Figured specimen from the Kiowa shale, Fredericksburg group, from the south bluff of the Medicine Lodge River, in the E½, Sec. 16, T. 30 S., R. 17 W., Kiowa County, Kansas.

Type.—Figured specimen, U. S. National Museum No. 112537.

GENUS **LINGULINA** D'ORBIGNY, 1826

Lingulina furcillata BERTHELIN

Plate 2, figures 13a-b

Lingulina furcillata BERTHELIN, 1880, Soc. géol. France, Mém., Sér. 3, vol. 1, Mém. 5, p. 65, pl. 4 (27), figs. 6a-c. ———, EGGER, 1899, Bayer. Akad. Wiss. Munchen, Abh., Cl. II, Bd. 21, p. 85, pl. 23, figs. 28-30. ———, TAPPAN, 1940, Jour. Paleon. vol. 14, no. 2, p. 106, pl. 16, figs. 18a-c. ———, TAPPAN, 1943, Jour. Paleon., vol. 17, no. 5, p. 499, pl. 80, figs. 11a-b. ———, LOZO, 1944, Amer. Mid. Nat., vol. 31, no. 3, p. 557, pl. 4, fig. 14.

Test free, tiny, elongate, flattened, uniserial, rectilinear, proloculus rounded, followed by low and broad arched chambers; sutures distinct, arched; wall calcareous, surface smooth; aperture an elongate terminal slit.

Length of hypotype, 0.37 mm.; greatest breadth, 0.11 mm.; greatest thickness, 0.06 mm.

Discussion.—This species was originally described from the Albian of France and has been recorded throughout the Washita group of Texas.

Occurrence.—Comanchean Series, Lower Cretaceous. Hypotypes from the south bluff of the Medicine Lodge River in the E½, Sec. 16, T. 30 S., R. 17 W., Kiowa County, Kansas.

Types.—Figured hypotype, U. S. National Museum No. 112517; unfigured hypotype, University of Kansas.

Lingulina sp.

Plate 2, figures 12a-b

Test free, tiny, uniserial, elongate, flattened; chambers increasing in size as added, last chamber comprising about one-third the length of the test; sutures distinct, slightly depressed, somewhat arched; wall calcareous, surface smooth; aperture terminal, an elongate slit.

Length of figured specimen, 0.19 mm.; greatest breadth, 0.06 mm.; greatest thickness, 0.05 mm.

Discussion.—This form differs from *Lingulina furcillata* BERTHELIN in being smaller, having less arched sutures, and in having a more pointed base and rounded cross-section. Rarity of specimens prevents definite specific determination.

Occurrence.—Comanchean Series, Lower Cretaceous. Figured specimen from the south bluff of the Medicine Lodge River, in the E½, Sec. 16, T. 30 S., R. 17 W., Kiowa County, Kansas.

Type.—Figured specimens, U. S. National Museum No. 112533.

SUBFAMILY **LAGENINAE**

GENUS **LAGENA** WALKER & JACOB, 1798

Lagena exomala, new species

Plate 2, figure 11

Test free, consisting of a single globular chamber; wall calcareous, surface smooth; aperture rounded, at the end of a short neck.

Length of holotype, 0.23 mm.; greatest diameter, 0.19 mm. Other specimens vary from 0.16 to 0.23 mm. in length.

Discussion.—This form is similar to *Lagena globosa* MONTAGU, but it is slightly smaller in size and possesses an eccentric aperture. It differs from *L. apiculata* (REUSS) in being globular rather than ovate and in lacking the basal spine, and from *L. vulgaris* WILLIAMSON in being about one-fourth smaller and in possessing a shorter neck.

Occurrence.—Comanchean Series, Lower Cretaceous. Holotype from the Kiowa shale, Fredericksburg group, along the south bluff of the Medicine Lodge River, in the E½, Sec. 16, T. 30 S., R. 17 W., Kiowa County, Kansas.

Types.—Holotype, U. S. National Museum No. 112535; unfigured paratype, University of Kansas.

FAMILY POLYMORPHINIDAE

SUBFAMILY POLYMORPHININAE

GENUS PYRULINA D'ORBIGNY, 1839

Pyrulina carebara, new species

Plate 2, figures 14a-c

Test free, small, elongate, fusiform, acuminate at both ends; chambers elongate, embracing, last chambers reaching approximately five-sixths of the length of the test; sutures distinct, depressed; wall calcareous, surface smooth; aperture terminal, radiate.

Length of holotype, 0.30 mm.; greatest breadth, 0.17 mm.; greatest thickness, 0.14 mm. Other specimens vary in length from 0.21 to 0.37 mm.

Discussion.—This species is similar to *Pyrulina acuminata* D'ORBIGNY, but differs in being about one-fourth as large, in having more depressed sutures and inflated chambers, and a less circular cross-section.

Occurrence.—Comanchean Series, Lower Cretaceous. Holotype from the Kiowa shale, Fredericksburg group, along the south bluff of the Medicine Lodge River, in the E½, Sec. 16, T. 30 S., R. 17 W., Kiowa County, Kansas.

Types.—Holotype, U. S. National Museum No. 112505; unfigured paratypes, University of Kansas.

FAMILY HETEROHELICIDAE

SUBFAMILY GUMBELININAE

GENUS GÜMBELITRIA CUSHMAN, 1933

Gümbelitria harrisi TAPPAN

Plate 2, figures 15a-18

Gümbelitria harrisi TAPPAN, 1940, Jour. Paleon. vol. 14, p. 115, pl. 19, fig. 2a-b. ———, TAPPAN, 1943, Jour. Paleon. vol. 17, p. 507, pl. 81, figs. 13-14b.

Test free, tiny, triserial, sides flaring rapidly; chambers globular, increasing rapidly in size from the minute proloculus; sutures distinct, depressed; wall calcareous, finely perforate, surface smooth; aperture a low arch at the base of the last chamber.

Length of hypotype (fig. 15), 0.135 mm.; greatest breadth, 0.07 mm. Length of hypotype (fig. 17), 0.09 mm. Length of hypotype (fig. 16), 0.10 mm.; greatest breadth, 0.11 mm. Length of hypotype (fig. 18), 0.10 mm.; greatest breadth, 0.10 mm.

Discussion.—*Gümbelitria harrisi* TAPPAN was originally described from the Grayson formation of Texas and it occurs throughout the Washita group of Texas and Oklahoma.

Occurrence.—Comanchean Series, Lower Cretaceous. Hypotypes from the Kiowa shale, Fredericksburg group, along the south bluff of the Medicine Lodge River, in the E½, Sec. 16, T. 30 S., R. 17 W., Kiowa County, Kansas.

Types.—Hypotypes, U. S. National Museum Nos. 112504a to 112504d; unfigured hypotypes, University of Kansas.

SUBFAMILY EOUVIGERININAE

GENUS EOUVIGERINA CUSHMAN, 1926

Eouvigerina laxistoma LOEBLICH & TAPPAN

Plate 2, figures 19a-c

Eouvigerina laxistoma LOEBLICH & TAPPAN, 1946, Jour. Paleon., vol. 20, p. 254, pl. 37, figs. 10-12.

Test free, tiny, elongate, biserial at the base, becoming irregularly triserial; chambers inflated, later ones higher than broad; sutures distinct, depressed; wall calcareous, finely perforate, surface smooth; aperture terminal, rounded, at the end of a distinct neck.

Length of hypotype, 0.21 mm.; greatest breadth, 0.07 mm.; greatest thickness, 0.06 mm.

Discussion.—*Eouvigerina laxistoma* LOEBLICH & TAPPAN has been recorded from the Weno, Paw Paw, Main Street, and Grayson formations of Texas. Kiowa specimens seem to differ from the types by being slightly more tapered. This species is extremely rare in the Kiowa formation.

Occurrence.—Comanchean Series, Lower Cretaceous. Hypotype from the Kiowa shale, Fredericksburg group, along the south bluff of the Medicine Lodge River, in the E½, Sec. 16, T. 30 S., R. 17 W., Kiowa County, Kansas.

Type.—Hypotype, U. S. National Museum No. 112510.

FAMILY BULIMINIDAE

SUBFAMILY BULIMININAE

GENUS BULIMINA D'ORBIGNY, 1826

Bulimina nannina TAPPAN

Plate 2, figures 20a-c

Bulimina nannina TAPPAN, 1940, Jour. Paleon., vol. 14, p. 116, pl. 19, figs. 4a-b. ———, TAPPAN, 1943, Jour. Paleon., vol. 17, p. 507, pl. 81, fig. 15.

Test free, tiny, triserial, rounded in section; chambers inflated, final chambers comprise over one-third the length of the test; sutures distinct, depressed; wall calcareous, surface smooth; aperture loop-shaped, in the face of the last formed chamber.

Length of hypotype, 0.17 mm.; greatest breadth, 0.09 mm.

Discussion.—*Bulimina nannina* TAPPAN has been previously recorded from the Grayson and Duck Creek formations of Texas and Oklahoma and is fairly common in some samples of the Kiowa formation.

Occurrence.—Comanchean Series, Lower Cretaceous. Hypotypes are from the Kiowa shale, Fredericksburg group, from the south bluff of the Medicine Lodge River, in E½, Sec. 16, T. 30 S., R. 17 W., Kiowa County, Kansas.

Types.—Hypotype, U. S. National Museum No. 112508; unfigured hypotypes, University of Kansas.

GENUS **NEOBULIMINA** CUSHMAN & WICKENDEN, 1928

Neobulimina primitiva (CUSHMAN), new combination

Plate 2, figures 21a-c

Virgulina primitiva CUSHMAN, 1936, Spec. Pub. Cushman Lab. Foram. Res. 6, p. 46, pl. 7, figs. 1a-c. ———, CUSHMAN, 1937, Spec. Pub. Cushman Lab. Foram. Res. 9, p. 2, pl. 1, figs. 1-3. ———, Lozo, 1944, Amer. Mid. Nat. vol. 31, pp. 560-561.

Test free, tiny, triserial at the base, later biserial, test flaring gradually at first, sides later subparallel, periphery rounded; chambers numerous, increasing very gradually in size; sutures distinct, very slightly oblique; wall calcareous surface smooth; aperture a narrow arch at the inner margin of the final chamber.

Length of figured hypotype, 0.25 mm.; greatest breadth, 0.09 mm.; greatest thickness, 0.08 mm.

Discussion.—This species was originally described as a *Virgulina* from the Goodland formation but seems to fit the generic diagnosis of *Neobulimina* more closely, particularly in the strongly triserial earlier portion which is followed by an uncompressed biserial stage.

Occurrence.—Comanchean Series, Lower Cretaceous. Hypotypes from the Kiowa shale, Fredericksburg group, along the south bluff of the Medicine Lodge River, in E½, Sec. 16, T. 30 S., R. 17 W., Kiowa County, Kansas.

Types.—Hypotype, U. S. National Museum No. 112506; unfigured hypotype, University of Kansas.

FAMILY **GLOBIGERINIDAE**

SUBFAMILY **GLOBIGERININAE**

GENUS **GLOBIGERINA** D'ORBIGNY, 1826

Globigerina graysonensis TAPPAN

Plate 2, figures 22a-c

Globigerina graysonensis TAPPAN, 1940, Jour. Paleon. vol. 14, p. 122, pl. 19, figs. 15-17. ———, TAPPAN, 1943, Jour. Paleon. vol. 17, p. 513, pl. 82, figs. 15a-c.

Test free, minute, trochoid, commonly about two complete coils visible on the dorsal side, only the last whorl visible ventrally, test convex dorsally, ventrally umbilicate; chambers inflated, almost globular; sutures distinct, depressed; wall calcareous, surface smooth; aperture at the lower margin of the last chamber, ventral in position.

Greatest diameter of hypotype, 0.10 mm.; least diameter, 0.09 mm.; greatest thickness, 0.07 mm.

Discussion.—Kiowa specimens of *Globigerina graysonensis* TAPPAN are slightly smaller than specimens from the Washita group. It is fairly common in some samples from the Kiowa formation.

Occurrence.—Comanchean Series, Lower Cretaceous. Hypotypes from the Kiowa shale, Fredericksburg group, along the south bluff of the Medicine Lodge River in the E½, Sec. 16, T. 30 S., R. 17 W., Kiowa County, Kansas.

Types.—Hypotype, U. S. National Museum No. 112536; unfigured hypotype, University of Kansas.

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