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Cover Picture

BLUE RIVER GRABEN

The southeastern part of the Arbuckle Mountains consists mainly of Precambrian granite, exposed as the result of strong vertical uplift and deep erosion during Pennsylvanian time. At least 15,000 feet of Paleozoic sedimentary rocks have been removed by erosion over most of the granite area. The ancient rocks are pink coarse-grained Tishomingo and Troy Biotite Granites, dated by means of radioisotopes at 1,400 million years. They extend over an outcrop area of 150 square miles and are characterized topographically as a gently rolling plain, covered partly by a forest of oak and hickory trees and partly by a grassy prairie used for pasturing beef cattle.

All parts of the Arbuckle Mountains, including the area underlain by Precambrian granites, are cut by long northwestward-trending faults that originated during the time of Pennsylvanian mountain building. The uplifted granite area itself is separated from marginal Paleozoic sediments by two of these major faults—the Washita Valley fault on the south and the Sulphur fault on the north—whereas the central part of the granite area is broken by a down-faulted block or graben. This is the Blue River graben, shown on the cover.

Two straight-line fault traces bound the graben. Within it are downfaulted light-colored limestones and dolomites of the Arbuckle Group, Late Cambrian and Early Ordovician in age. They are irregularly folded into a syncline, the dips of the limbs normally ranging between 20° and 35°. The graben is 2,000 feet wide where crossed by Blue River, at the lower right corner of the photograph, and nearly a mile wide at the upper left. All the rocks outside the graben are Precambrian granite.

At no place can the faults be directly observed and their dip measured in the field, but a slight indentation of the trace of the southwestern fault at Blue River suggests that it dips northeastward at a moderately high angle. The opposite fault presumably dips in a similar manner into the graben, and both are interpreted as normal faults. Net throw on the two faults is of the order of 10,000 feet.

The area shown is in the central part of Johnston County, about 10 miles northeast of Tishomingo and the scale of photograph is approximately 3.2 inches per mile.

—W. E. H.

Variation of Magnetic Susceptibility in the Blaine Formation (Permian), Northern Blaine County, Oklahoma

J. A. E. Norden and C. J. Mankin

INTRODUCTION

Clay-petrology and geochemistry studies of the Blaine Formation (Permian) in northern Blaine County, Oklahoma, conducted by A. G. Everett (1962), contributed a great deal of information on the vertical and lateral distribution of clay minerals in this redbed-evaporite sequence.

Because the presence of detrital magnetite and ilmenite in redbeds (Miller and Folk, 1955) may influence the variation of the magnetic susceptibility of a formation (Nettleton, 1940), the senior author suggested that samples from a vertical section of the Blaine Formation measured by A. G. Everett should be tested for magnetic susceptibility. For the careful assembling of samples to be tested, the help of A. G. Everett is gratefully acknowledged.

The clay mineral and geochemical investigation was supported in part by National Science Foundation Grant G19186, entitled *Mineralogy and chemistry of Permian shales, Anadarko basin, Oklahoma, Kansas, and Texas.*

MEASUREMENT OF MAGNETIC SUSCEPTIBILITY

The magnetic susceptibility of the samples was measured by means of a magnetic-susceptibility bridge, Model MS-3.* This instrument provides high-precision measurements of rock susceptibilities which are made in a magnetic field of the same order of magnitude as that of the Earth's field. Because the field used in the MS-3 is produced by alternating current, the instrument neither measures nor is affected by remanent magnetization (Geophysical Specialties Co., 1962). Samples used in susceptibility measurements were rock chips averaging 4 mm in diameter, for which a volume correction was applied. Owing to the presence of the magnetically inert material (air) between the rock chips and the wall of the sample holder, the ratio of true density (D_m) and apparent density (D_a) was determined by

$$\frac{D_m}{D_a} = \frac{(1\text{-}3/16)^2}{d^2} \times \frac{50}{50 - V_w}$$

where d is the diameter of the sample holder and V_w is the volume of water filling the inert space in the 50-cc sample holder. The measured

*Geophysical Specialties Co., Hopkins, Minn.

volume susceptibility, k_a, of a mixture of M_m grams of magnetic material with M_i grams of inert material is

$$k_a = D_a \times \frac{k_m}{D_m} \times \frac{M_m}{M_m + M_i}$$

where k_m is true susceptibility. As the inert material is air, the true sample susceptibility can be determined by

$$k_m = \frac{D_m}{D_a} k_a$$

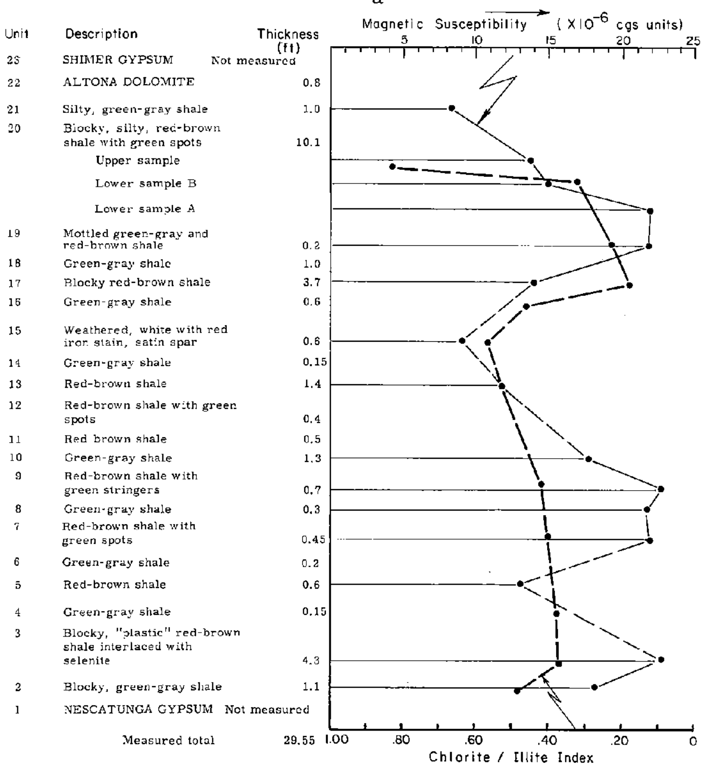

Figure 1. Comparison of magnetic susceptibility (increasing to right) with chlorite/illite index (increasing to left) of a section between the Altona Dolomite and Nescatunga Gypsum in west face of Keene's quarry of United States Gypsum Company, SW¼ SW¼ NW¼ sec. 11, T. 18 N., R. 12 W. Lithologic descriptions and chlorite/illite indices are from Everett (1962).

For the measurements of the volume susceptibility, k_a, the MS-3 magnetic-susceptibility bridge was applied and readings were made by means of a cathode-ray oscilloscope. After the establishment of the balance on the bridge, the difference in resistance due to the sample was read and converted to volume susceptibility, k_a, by

$$k_a = 3.57 \times 10^{-6} \times R \quad \text{cgs units}$$

where R is the difference in resistance in ohms after re-balancing the bridge. The value of k_a was then multiplied by the correction factor for $\frac{D_m}{D_a}$ in order to obtain the true susceptibility, k_m.

AREA AND MINERALOGY OF SAMPLES INVESTIGATED

Fifteen samples from the west face of the Keene's quarry, United States Gypsum Company (SW¼ SW¼ NW¼ sec. 11, T. 18 N., R. 12 W.), northern Blaine County, Oklahoma, were tested. Selective samples were taken from a measured section of the quarry in which the Blaine Formation (Guadalupian) is exposed. Susceptibility measurements were made on samples between the Altona Dolomite and the Nescatunga Gypsum of the Blaine Formation. In figure 1 the samples tested for magnetic susceptibility are denoted by a horizontal line tying to the vertical section measured by A. G. Everett.

The clay mineralogy was determined by X-ray-diffraction and differential-thermal-analysis methods. The diffraction data were obtained with copper $K\alpha$ radiation from a Siemens Crystalloflex IV constant-potential generator and recorder. The differential thermal analyses were obtained by using a Stone dynamic-gas model 13-M DTA unit with nitrogen gas as the purging medium.

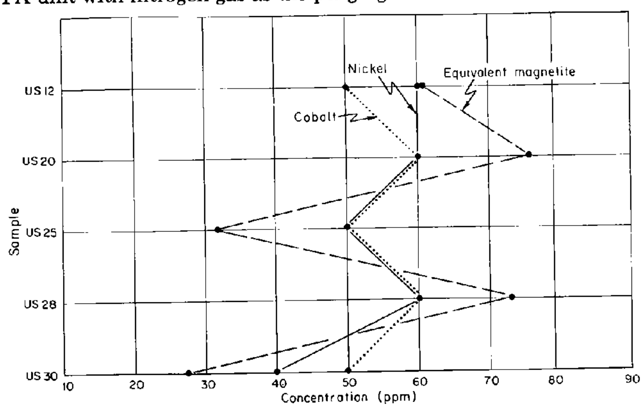

Figure 2. Comparison of nickel and cobalt trace-element concentration with equivalent-magnetite concentration in shales of the Blaine Formation. Sample numbers and trace-element concentrations are from Everett (1962). Equivalent-magnetite concentrations are from table I.

TABLE I.—CONCENTRATIONS OF EQUIVALENT MAGNETITE IN SAMPLES FROM THE BLAINE FORMATION

Sample Number[1]	Concentration of Equivalent Fe_3O_4 (ppm)*
2(US 12)	60.7
3(US 13)	75.7
5(US 14)	43.0
7(US 17)	73.4
8(US 19)	72.7
9(US 20)	75.7
10(US 23)	59.2
13(US 24)	39.8
15(US 25)	31.8
17(US 26)	46.7
19(US 27)	72.8
20(US 28, lower sample A)	73.0
21(US 30)	27.3

[1] Sample numbers in parentheses are those of Everett (1962).
* Fe_3O_4 content computed from magnetic-susceptibility measurements.

The framework clay mineralogy of the interval between the Altona Dolomite and the Nescatunga Gypsum is basically a mechanical mixture of illite and a poorly defined chlorite. The illite contains some expandable layers, probably a result of potassium removal through weathering in the source area. No readily expandable clay minerals (montmorillonite or vermiculite) are present in the section and DTA data confirm the absence of kaolinite.

In an effort to show the variation in the illite and chlorite content of this section, Everett (1962) developed a relative scale which he described as the "chlorite/illite index." This ratio was obtained by using sedimented-slide X-ray diffraction methods and measuring the peak areas of the 5A peak of illite and the 7A peak of chlorite. The ratio was defined by the following expression:

$$\text{Chlorite/Illite Index} = \frac{\text{Intensity of 7A chlorite peak}}{2 \times \text{Intensity of 5A illite peak}}$$

The vertical variation of this ratio for the section measured in the Keene's quarry is shown in figure 1.

RESULTS OF THE MAGNETIC SUSCEPTIBILITY MEASUREMENTS

The range of the magnetic susceptibility of samples was found to be 8.18×10^{-6} to 22.7×10^{-6} cgs units. Two distinct zones of relatively higher susceptibility can be recognized within the vertical section. These zones seem to correlate with the plot of Everett's chlorite/illite index, which is plotted in a direction opposite to that of the magnetic-susceptibility increase on figure 1. The similarity in the trends of the magnetic susceptibility and of the chlorite/illite index plots (fig. 1) can be interpreted as being due to a variation of the iron content of these minerals. At the zones of higher magnetic susceptibility the chlorite/illite index is low. Accordingly, high illite content of the formation may correlate with higher magnetic susceptibility zones.

Magnetic susceptibility of a rock may be dependent upon its content of finely disseminated magnetite (Fe_3O_4). Slichter (1929) stated that the effective susceptibility of magnetite in a field the strength of which is that of the Earth's and in disseminated form as a rock constituent is 300,000 $\times$ 10^{-6} cgs units. Thus, according to Slichter, the susceptibility of a rock can be determined by

$$\underline{k} = 300{,}000 \times 10^{-6} \times P$$

where P is the percentage (by volume) of disseminated magnetite. Because the susceptibility of the samples from Keene's quarry was determined by the use of the magnetic-susceptibility bridge, the equation given by Slichter was applied as an approximation of the equivalent-magnetite content of the samples. Samples with their computed approximate equivalent-magnetite content are given in table I.

For a comparative study the equivalent-magnetite dissemination graph was plotted in parts per million units alongside the nickel and cobalt concentration data of Everett (fig. 2). These trace elements are commonly associated with iron. The computed equivalent-magnetite (Fe_3O_4) content of the samples correlates to a high degree with the zones of nickel and cobalt concentration.

CONCLUSIONS

The correlation of magnetic susceptibility to the clay mineralogy of the Blaine Formation indicates that this geophysical approach to stratigraphic investigations has definite relationships to the conditions disclosed by geochemical studies of the same sediments.

It is hoped that further studies of a similar nature may bring more evidence to support the practical application of a geochemical-geophysical correlation method in the Blaine and similar formations.

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A PLEISTOCENE LOCAL FAUNA FROM CADDO AND CANADIAN COUNTIES, OKLAHOMA

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Many relatively deep canyons have been eroded in the drainage basins of the Washita and Canadian Rivers of Caddo and Canadian Counties, near Hinton, Oklahoma. These canyons have been produced mainly in Rush Springs and Marlow Formations of the Whitehorse Group, Permian in age. During late Pleistocene time these canyons were refilled by sediment but have been partly reexcavated during the Recent. Ecological studies conducted in this region resulted in the discovery of several rather large deposits of mollusks, pollen, and seeds. The authors are attempting to identify the relative ages of these deposits. The pollen and seeds obtained from the various localities recorded below are being analyzed by L. R. Wilson, Oklahoma Geological Survey. The name Caddo Local Fauna is proposed for the mollusks collected from secs. 4, 9, T. 11 N., R. 10 W., and secs. 2, 3, T. 12 N., R. 11 W., Canadian and Caddo Counties, Oklahoma.

PREVIOUS WORK

Although much paleontological work has been accomplished on the various Pliocene-Pleistocene molluscan faunas of western Kansas, only a few such studies have been published on the Oklahoma counterpart. Leonard and Franzen (1944) analyzed Mollusca of a lower Pliocene deposit and Taylor (1954) analyzed a late Pleistocene deposit, both in Beaver County. Hibbard (1954) and Herrington and Taylor (1958) referred to the few Pliocene mollusks found in the Buis Ranch fauna in the same county, the latter fauna having been discussed in some detail by Taylor (1960). Taylor and Hibbard (1955) discussed a Pleistocene fauna from Harper County and Ho and Leonard (1961) described a new species of *Strobilops* from some Kansan deposits in Woodward County. Other published papers with direct bearing upon the Pleistocene mollusks of Oklahoma are not known to the authors.

METHODS

Eighty-one samples, each one-twentieth of a cubic foot in volume, were taken from three localities, one in Caddo County and two in Canadian County. These samples yielded 1,667 molluscan specimens (and many fragments) representing two classes, 15 families, 28 genera, and 53 species. Collecting procedures differed according to conditions encountered at each station. These localities were selected for sampling because at these the banks, or walls, are nearly vertical. A plumb bob was used and, to guard against contamination, the surface of the stream cut was scraped to the vertical. Samples were taken at each foot, from bottom to top, at each location. Each sample was sorted through a 2.0 mm sieve.

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COLLECTING SITES

Station one. Water Canyon, approximately 300 yards upstream from the northeast corner of sec. 4, T. 11 N., R. 10 W., Canadian County. Thirty-six samples were taken, 12 from each of three tiers, 7.5 feet apart. Each tier lies 9 feet above the stream bed and extends upward to 22.5 feet below the top of the bank. The site where each sample was taken, in addition to some of the other data mentioned above, is designated in figure 1 for ease of text reference.

Station two. Niles Branch, near junction with main branch of Water Canyon at the middle of sec. 9, T. 11 N., R. 10 W., Canadian County. Twenty-seven samples were taken, 9 from each of three tiers, 9 feet apart (fig. 2).

Station three. Fisher Canyon of Canadian River, near north line of sec. 23, T. 12 N., R. 11 W., Caddo County. Eighteen samples were taken, 9 from each of two tiers, 9 feet apart (fig. 3).

STRATIGRAPHY

The beds in which these mollusks occur are probably of late Pleistocene deposition, i. e., glacial Illinoisan. The presence of several species which are now characteristic of moist, cooler, and more northern latitudes indicates a glacial rather than an interglacial period. The occurrence of several specimens of *Physa skinneri* militates against the beds' being of Wisconsinan age. Carbon dating would allow us to estimate the age somewhat more realistically, and the seeds collected from these sites should be so treated.

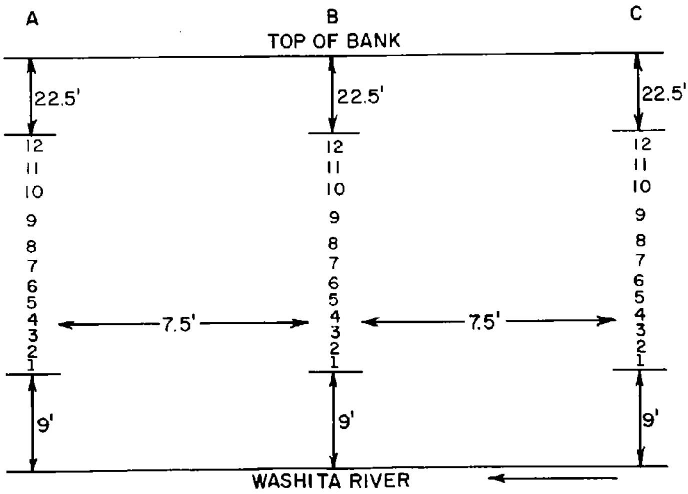

Figure 1. Diagram showing positions of collecting sites at station one, Canadian County, Oklahoma.

Although land snails are abundant in these deposits, the presence of extensive forests is not indicated. The only large species present, belonging to a group characterizing eastern deciduous forests, is *Mesodon*. However, small growths of deciduous trees tend to spring up along the margins of the primarily westward- to southeastward-flowing streams. These strips of forest allow such forms as *Mesodon thyroidus* (Say) to extend their ranges westward (Branson, 1958). Taylor and Hibbard (1955) did not find specimens of *Mesodon* in the Harper County deposits. Several of the other land snails are rather obligate hydrophiles. *Carychium exiguum* (Say) normally is found along stream or pond margins in damp vegetation (Branson, 1961a), and Leonard (1959) reported the species as actually entering the water on occasion. The same can be said for the widespread *Catinella vermeta* (Say) and *Succinea concordialis* Gould (Miles, 1958).

Gyraulus parvus and *Helisoma anceps* are characteristic of vegetated bodies of water. The former is especially fond of sluggishly moving or standing waters with a thick growth of aquatic vegetation (Baker, 1928; Branson, 1961a). *Helisoma trivolvis* normally is found in stagnant backwaters (Baker, 1928). *Sphaerium striatinum* (Lamarck), *Pisidium compressum* Prime and *P. nitidum* Jenyns are species that are restricted to permanent bodies of water with some current action (Hibbard and Taylor, 1960). *Pisidium casertanum* (Poli), on the other hand, is often found in sluggish waters. Available ecological data

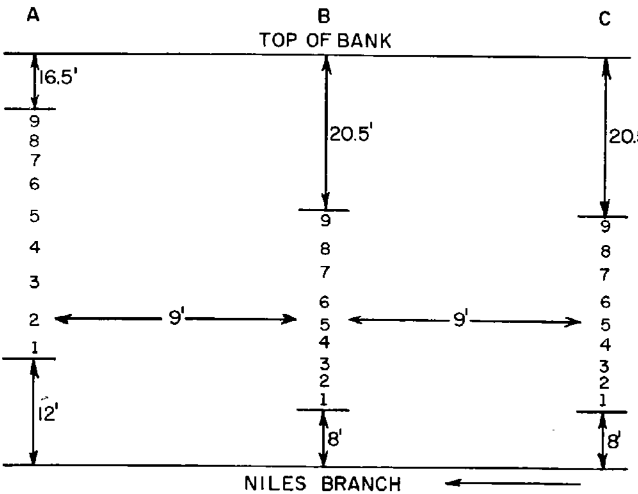

Figure 2. Diagram showing positions of collecting sites at station two, Canadian County, Oklahoma.

for the above species and for those yet to be discussed show some discrepancy among the species regarding the kind of habitat present during the time of deposition or possibly redeposition of some specimens in the upper strata.

The deposits form many narrow gray and black, siltlike strata. This fact suggests some sort of pond or lake situation offering a variety of habitats, i. e., wave-swept beaches (simulating a current) and vegetated lagoons. The presence of a relatively well-developed terrestrial fauna further suggests the presence of marginal forest development. This "pond" or "lake" could also have been in the form of a fairly wide place in a stream where sedimentation could take place at a slow rate or in a stream bed which was periodically flushed by stream swelling during a rainy season.

With some differences, stations one and two are similar and were possibly small sink-holes with small feeder streams. Station three, because of its larger and more diversified fauna, was possibly a larger body of water. This is especially probable since by far the greater percentage of specimens (table 1) are sluggish-water species. The presence of a fairly large number of terrestrial species also supports this idea. The relative abundance and percentage-composition, at each station, is shown in table 1.

ANNOTATED LIST OF SPECIES COLLECTED

In the following list the sites from which the specimens were collected are correlated with figures 1, 2, and 3. The first number indi-

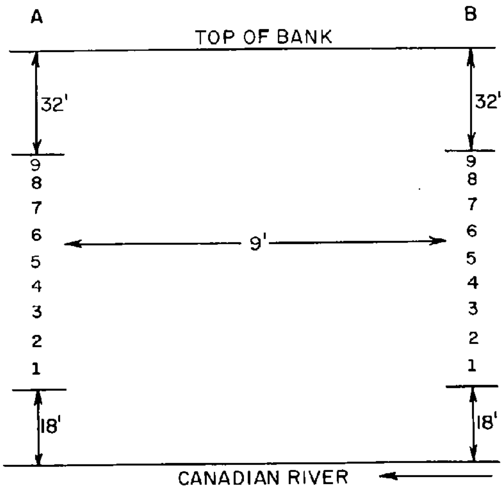

Figure 3. Diagram showing positions of collecting sites at station three, Caddo County, Oklahoma.

cates the station; the letter following it is the tier; the next number is the level; and the last one, in parenthesis, is the number of specimens found.

Pelecypoda

Sphaerium striatinum (Lamarck)

Collections: 2C3(1); 2C6(6); 2B6(2 + fragments); 2B9(5).

Upper Pliocene to Recent. This small distinctive clam is found in permanent, well-oxygenated bodies of water.

Sphaerium transversum (Say)

Collections: 2A7(2); 3B6(13); 3B4(1).

Middle Pleistocene to Recent. *S. transversum* prefers muddy- and silty-bottomed backwaters of ponds, lakes, and streams.

Pisidium casertanum (Poli)

Collections: 2B7(9); 2B8(3); 2B9(2); 2C5(3); 3A4(24); 3A 7(2); 3B5(80); 3B8(2).

Lower Pliocene to Recent. All of the specimens of this somewhat variable species are of Hibbard and Taylor's "heavy forms," a fact which indicates wave or stream action.

Pisidium compressum Prime

Collections: 1C9(10); 2B8(4); 2B9(2); 2C5(8).

Middle Pliocene to Recent. This species is found only in running streams and lakes with some wave action.

Pisidium nitidum Jenyns

Collections: 2B2(27); 2C4(5).

Lower Pliocene to Recent. *P. nitidum* occupies habitats similar to those of *P. compressum.*

Following the suggestion of Herrington (1945), the above-listed species were identified primarily by characters of the hinge. The specific epithets are also on his authority (Herrington, 1954).

Aquatic Gastropods

Prosobranchia—Amnicolidae

Pomatiopsis lapidaria (Say)

Collections: 3A6(2); 3B5(1); 3B6(6).

Middle Pleistocene to Recent. *Pomatiopsis* is an amphibious species which is always found in or near water. The only living specimens collected near Oklahoma have come from Arkansas. So far as we can discern, these are the only fossil specimens ever recorded from Oklahoma. A related species, *Probythinella lacustris limafondens* (Morrison), is known from Oklahoma (Branson, 1958) and Kansas (Hibbard and Taylor, 1960). The latter form is easily distinguished from *Pomatiopsis* by having the apical whorls depressed below the others.

Pulmonata—Basommatophora

Lymnaeidae

Following Hubendick (1951), all of the following species are placed in *Lymnaea,* the old genus being placed in parenthesis.

Lymnae (Stagnicola) palustris (Müller)

Collections: 1A5(1); 2A1(2).

Pleistocene to Recent. An inhabitant of temporary bodies of water, it is the form *reflexa* (Hubendick, 1951). It has not been found alive farther south than southern Kansas (Baker, 1928).

Lymnaea (Stagnicola) bulimoides (Lea)

Collections: 3B8(2).

Upper Pliocene to Recent. *L. bulimoides* lives in both temporary and permanent bodies of water and is relatively rare as a fossil (Hibbard and Taylor, 1960).

Lymnaea (Stagnicola) caperata (Say)

Collections: 3B8(4).

Middle Pliocene to Recent. Another occupant of temporary bodies of water (Baker, 1928), it is now found in cooler regions north of Kansas.

Lymnaea (Fossaria) humilis (Say)

Collections: *L. obrussa,* 1B5(1); *L. dalli,* 1C1(2); 2B2(2); 2C7(4); 3A6(12); 3B5(33); 3B6(47); 3B7(10); *L. parva,* 1B4 (1); 2A2(2); *L. humilis,* 2A3(1); 3A4(24); 3A7(1); 3B6(35).

Lower Pliocene to Recent. As indicated above, these specimens included several shell types. However, Hubendick (1951) showed that these "species" are synonyms of *L. humilis.*

Lymnaea fragment

Collections: 2A1(1).

The fragment is not in condition for further indentification.

Planorbidae

Gyraulus circumstriatus (Tryon)

Collections: 1C1(2); 2A9(8); 2B2(3); 3A4(4); 3B5(1); 3B7(1).

Middle Pleistocene to Recent. This small species prefers quiet, stagnant waters with a sandy bottom and copious vegetation (Branson, 1961a). It is easily distinguished from the next species by its nearly circular whorls (in cross-section) and plane sides.

Gyraulus parvus (Say)

Collections: 1A4(1); 1B2(25); 1B3(228); 1B5(3); 1C1(36); 1C3(1); 2A7(1); 2A9(5); 2B2(2); 2B7(4); 2B8(25); 2B9(36); 2C6(22); 2C7(1).

Middle Pliocene to Recent. This species more often is found in quiet waters with abundant vegetation, often being the dominant aquatic gastropod in a given region.

Gyraulus fragments

Collections: 2B9 and 2C2. Many fragments, probably mixtures of the above two species, were found at these two sites.

Helisoma anceps (Menke)

Collections: 1B3(7); 1C1(6 + fragments); 2A9(1); 2B8(3); 2B 9(3); 2C5(1); 2C6(1).

Upper Pliocene to Recent. This species prefers vegetated streams but often is taken from small swales and ponds which have algal-covered bottoms.

Helisoma trivolvis (Say)

Collections: 1A1(1); 1A2(1); 1A4(1); 1A5(2); 1B5(3); 1C1(2 + fragments); 1C7(1); 2A9(1); 2B8(1); 2B9(1); 2C6(4); 3A7 (3); 3B7(9).

Upper Pleistocene to Recent. This is an exceedingly widespread species which is usually found in quiet backwaters and stagnant ponds.

Helisoma fragments

Collections: 1B2; 1B3; 2A5; 2A9; 2B2; 2B8; 2B9; 2C5; 2C6; 3A 6; 3A8; 3B7.

Many fragments were found at the above sites but none could be relegated to a species.

Ancyliidae

Ferrissia meekiana (Stimpson)

Collections: 2B7(3); 2B8(2).

Lower Pleistocene to Recent. This species is found in temporary bodies of water in the eastern United States. None of the shells was septate.

Laevapex fuscus (Adams)

Collections: 2A7(1).

Late Pleistocene to Recent. This form, which lives in shallow, moderately to slowly flowing water, was recently reported living in southeastern Oklahoma (Branson, 1961a).

Physidae

Physa anatina Lea

Collections: 1A2(1); 1A3(1); 1B3(27 + fragments); 1B4(4); 1C1(8); 1C9(2); 2A8(1); 2B2(19); 2B8(3); 2C4(1); 2C6(9); 2C7 (9); 3A6(1); 3A7(3); 3B6(5); 3B7(9).

Upper Pliocene to Recent. *Physa anatina* is a widespread species in the Great Plains from the Mississippi to Colorado. It inhabits nearly any aquatic habitat (Branson, 1961a).

Physa gyrina Say

Collections: 1A4(1); 1B2(18); 1C3(1); 2A9(9); 2B9(4).

Lower Pleistocene to Recent. Hibbard and Taylor (1960) stated that *P. gyrina* may not occur in the southern Great Plains except as a fossil. However, it is one of the more common species in Oklahoma (Branson, 1961a). This multivalent form can withstand a great deal of habitat variation.

Physa skinneri Taylor

Collections: 3A7(2); 3B7(7).

Lower Pleistocene to Recent. Ecological data for this species are scanty. Taylor found the species in small temporary ponds in Utah. It does not live in Oklahoma and Kansas and heretofore has only been recorded in two Pleistocene sites near the state. Taylor (1954) found it in a Nebraskan locality (Dixon Local Fauna) in Kansas and in an

Illinoisan deposit in Beaver County, Oklahoma (Taylor and Hibbard, 1955).

Physa fragments

Collections: 1A12(1); 1B9(many); 2A9(many); 2B8(many); 2 C5(few); 2C6(many); 3B7(many); 3B8(2).

None of these fragments, probably mixtures of *P. gyrina* and *P. anatina*, could be assigned with certainty to any species.

Terrestrial Gastropods

Basommatophora

Carychium exiguum (Say)

Collections: 2B2(16); 3A5(6); 3A7(1); 3B5(14); 3B6(16); 3B 7(1).

Lower Pliocene to Recent. This minute species normally is found associated with bodies of water where it dwells under decaying organic debris. At present it is found living only in the eastern one-third of the State. This is the only terrestrial basommatophoran in the area.

Stylommatophora

Strobilopsidae

Strobilops labyrinthica (Say)

Collections: 2B2(12); 3A4(7); 3A7(5).

Upper Pliocene to Recent. *S. labyrinthica* is a woodland form normally found in decaying wood or under rocks overlying humus.

Strobilops lonsdalei Ho and Leonard

Collections: 3A4(3); 3A6(2); 3B5(14); 3B6(12); 3B7(3).

Upper Pleistocene. Ho and Leonard (1961) recorded two subspecies of this form for Oklahoma (Greer and Beaver Counties), Kansas, and Texas. *S. l. lonsdalei* was supposedly a southern race, whereas *S. l. cansasiana* a northern one. However, the specimens from the present sites do not allow of subspecies recognition. This region may have been intergradational. This species is most closely related to *S. sparsicostata* Baker (lower Pleistocene) and *S. texasiana* Pilsbry and Ferriss, a Recent species. The latter form is considered as a variant of *S. labyrinthica* by the senior author (Branson, 1961b).

Strobilops sparsicostata Baker

Collections: 2B2(3).

Lower and Middle Pleistocene. These specimens, having the dentation and sculpture of *S. sparsicostata*, are possibly the result of secondary deposition because the species is not known to occur with *S. labyrinthica*.

Pupillidae

Gastrocopta cristata (Pilsbry and Vanatta)

Collections: 2A4(1); 2B8(1).

Upper Pleistocene to Recent. This is a sylvan or grassland species which has a fairly high moisture requirement. It is widely distributed in the Great Plains.

Gastrocopta procera (Gould)

Collections: 2B3(5); 2B7(1); 2B8(1); 2C1(1); 2C5(2); 2C7 (1).

Lower Pleistocene to Recent. This is common snail in the Great Plains where it is primarily found in timbered regions.

Gastrocopta pellucida (Pilsbry)

Collections: 1C12(2); 2B7(1); 3A5(1).

Late Pliocene to Recent. According to Hibbard and Taylor (1960), this species is rare as a fossil. However, there is a good possibility that many of the specimens collected from stream drift are upper Pleistocene-early Recent fossils or subfossils.

Gastrocopta armifera (Say)

Collections: 1A12(1); 1B10(1); 1C12(1); 2A4(1); 2A8(1); 2B2 (1); 2B3(4); 2B7(1); 2B8(1); 2C2(1); 2C5(3); 3A5(9); 3B6(1).

Lower Pliocene to Recent. *G. armifera* is distinctly woodland in preference but is found in a variety of habitats. It may not occur as a living species in the western counties.

Gastrocopta contracta (Say)

Collections: 2A4(1); 2B3(2); 3A5(2); 3B6(4); 3B8(1).

Lower Pliocene to Recent. This species is widely distributed throughout the Great Plains, where it is usually found under dead grass and wood (Franzen and Leonard, 1947). Considerable variation is seen from one locality to the next and several "races" have been based upon various shell phenotypes.

Gastrocopta falcis Leonard

Collections: 3B5(1).

Middle to Upper Pleistocene. This species has rarely been reported. It may be recognized by its widely divergent parietal and angular lamellae.

Gastrocopta tappaniana (Adams)

Collections: 2A1(1); 2B2(10); 2B7(1); 2B8(1); 2C5(1); 3A4 (12); 3A6(3); 3A7(6); 3B5(10); 3B6(16).

Upper Pliocene to Recent. A common, small species, more often found in the wooded margins of streams.

Gastrocopta fragments

Collections: 2C4(1); 2C9(1); 3A8(3).

Pupoides albilabris (Adams)

Collections: 1C12(2); 2B3(1); 2B8(1); 2C2(1); 2C7(1); 3A5(1).

Lower Pliocene to Recent. *Pupoides albilabris* is tolerant of high summer temperatures (Franzen and Leonard, 1947) but occupies microclimates at the bases of various plants.

Pupoides inornatus Vanatta

Collections: 2C5(1).

Lower Pliocene to Recent. Although *P. inornatus* is resistant to dry conditions, usually being found under talus and other calcareous debris, it has retracted its range north and westward. It is a rare Pleistocene fossil.

Vertigo ovata Say

Collections: 1B4(1); 3B6(2).

Lower Pliocene to Recent. *Vertigo ovata* is an obligate hydrophile found near streams and ponds. During heavy rains it can be collected as it crawls over the surface of grasses, sedges, and the like.

Valloniidae

Vallonia gracilicosta Reinhardt

Collections: 1C6(1).

Late Pliocene to Recent. Although only a single specimen was collected, fossil shells of this form are common in stream debris in western Oklahoma. It lives at relatively high altitudes under decaying wood, etc.

Vallonia parvula Sterki

Collections: 1A10(1); 1B5(1); 1B10(1); 1C12(2); 2B3(1); 2B7(2); 2C1(1); 2C3(1); 2C7(1); 2C9(1); 3A5(3).

Upper Pliocene to Recent. This species is common in Pleistocene deposits and as a Recent living form in all but extreme western Oklahoma. It thrives under turf, decaying wood, and other organic substances along stream margins.

Succineidae

As pointed out by Miles (1958), Hibbard and Taylor (1960), and others, the shells of succineid snails offer only poor taxonomic characters. Specific identification, with some exceptions, normally involves dissection of the soft anatomy. However, the first species below is rather easily recognized by its shell.

Succinea concordialis Gould

Collections: 2B1(4); 2B2(22).

Upper Pleistocene to Recent. This species normally is associated with bodies of water, often actively entering them. *S. grosvenori* Lea is probably a synonym of this species.

Catinella vermeta (Say)

Collections: 1B4(1); 2A3(2); 2A4(1); 2A8(2); 2B5(5); 2B7(1); 2C2(2); 3A4(4); 3A5(1); 3A7(5); 3B6(12); 3B7(8).

Upper Pleistocene to Recent. This form is often found moving about on aquatic vegetation, especially in hot summer. It also often inhabits leaf mold, decaying wood, and the undersides of large stones.

This species has been known as *Succinea avara* Say and *Quickella vermeta* (Say), (Hubricht, 1958). Webb (1953) pointed out the taxonomic difficulty involved in identifying *Succinea avara* and described three new species after dissection of several specimens which appeared to be that species. However, Hubricht (1958) showed that this form, because of nomenclatural problems, should be *Q. vermeta,* which is a member of the subgenus *Mediappendix.* Odhner (1950) erected a new subfamily (Catinellinae) for the forms in *Mediappendix (Catinella* and *Quickella)* and elevated the subgenus *Catinella* to full generic rank. The anatomical differences between *Quickella* and *Cati-*

nella are marked: the former has a knobbed penis and the latter has a strongly appendiculated one (Grimm, 1960). "*Succinea avara*" has a penis of the latter type and is thus in the genus *Catinella*. The specific epithet *avara* in unavailable (Hubricht, 1958) and must be replaced by *vermeta*. Webb's (1953) *Quickella* species should be reviewed carefully.

Although some of the foregoing is purely legalistic in context, it is important that the form referred to be clearly delineated. It is highly desirable that the whole family Succineidae be revised.

Oxyloma retusa (Lea)

Collection: 3B5(1).

Lower Pleistocene to Recent. This is another obligate hydrophilic and mycophagous species and normally is found near flowing or stagnant permanent bodies of water.

Succinea fragments

Collections: 1C12(1).

Endodontidae

Helicodiscus parallelus (Say)

Collections: 1B4(1); 2B3(3); 2C2(1); 2C4(1); 2C7(2); 3A5(4).

Lower Pleistocene to Recent. This species, normally found alive in decaying wood or other vegetable matter, is especially abundant along stream margins.

Helicodiscus singleyanus (Pilsbry)

Collections: 1C8(1); 1C12(2); 2A8(2); 2C2(2); 2C5(1); 3A5(1).

Upper Pliocene to Recent. This minute species is capable of living in relatively dry situations around grass and herbaceous plant roots.

Helicodiscus nummus (Vanatta)

Collections: 2B3(1); 2B8(2).

Upper Pleistocene to Recent. These minute shells compare favorably with Recent ones. So far as we know, this species has not heretofore been reported from Pleistocene deposits. Pilsbry (1948) was somewhat undecided as to the species' relationship. It is possible that *H. nummus* is only the young stage of some other species, such as *hawaiia*.

Anguispira alternata (Say)

Collections: 3B6(2).

Upper Pleistocene to Recent. This is a common snail in the eastern third of Oklahoma. It frequents wooded hills and the undersides of large stones. Although this snail is seldom reported, it is a fairly common late Pleistocene fossil.

Limacidae

Deroceras laeve (Müller)

Collections: 2A6(1); 3B5(1).

Middle Pleistocene to Recent. *D. laeve* is widely distributed in regions where moisture is abundant. It is not surprising that the shells of this slug should often be found as fossils in otherwise obviously aquatic assemblages. Although Frömming (1954) declined to concede the point, *D. laeve* actually does invade the bottoms of various bodies of water for the purpose of hibernation (Branson, 1959b). The fossils herein reported are nearly identical to the shells of Recent forms.

Deroceras aenigma Leonard

Collections: 2A2(1); 3A2(1); 3B6(3); 3B8(1).

Upper Pliocene to Upper Pleistocene (Wisconsinan). From the various localities reported for this fossil species, it is assumed that it occupied habitats similar to *D. laeve* (Hibbard and Taylor, 1960). The shell is much thicker and slightly longer than that of *D. laeve.* Its known geographic range is Iowa, Nebraska, Kansas, Oklahoma, Texas, and Ohio (La Rocque and Conley, 1956). Taylor (1954) recorded the species from Beaver County, Oklahoma.

Zonitidae

Euconulus fulvus (Müller)

Collections: 1B2(1); 3A5(1); 3B5(1).

Middle Pliocene to Recent. *E. fulvus* is primarily a species of upland regions where it is found under logs, bark, and leaves. We have not found it living on the Oklahoma plains. In this region *E. chersinus* is more common, *E. fulvus* being found only in the Ozark region.

Nesovitrea electrina (Gould)

Collections: 3A4(7); 3A6(2); 3B5(36); 3B6(10).

Upper Pliocene to Recent. This species now occurs only in extreme eastern Oklahoma, where the rainfall exceeds an annual average of 35 inches.

Retinella indentata (Say)

Collections: 1C10(2); 2A1(2); 2A4(1); 2A6(1); 2B2(23); 2B5 (1); 2B6(1); 2C1(1); 2C2(4); 2C7(2); 3A4(3); 3A5(4); 3A6(11); 3B5(21); 3B6(2); 3B7(13).

Middle Pleistocene to Recent. *R. indentata* is a widespread and common species which occupies a multitude of habitats. It can live in arid conditions around the bases of grassland plants or in marshes.

Pilsbryna tridens Morrison

Collections: 3A5(1); 3B6(1).

Middle Pleistocene to Recent. *P. tridens* is found in the southern Great Plains in the same places as *Helicodiscus parallelus*. Its morphology is similar to that of *Helicodiscus*, with which it may be congeneric. It has not heretofore been reported as a fossil from Oklahoma.

Hawaiia minuscula (Binney)

Collections: 1B2(3); 1B4(3); 1B12(3); 1C10(1); 1C12(1); 2A1(5); 2A2(1); 2A4(1); 2A6(2); 2B2(6); 2B3(5); 2B5(2); 2B6 (1); 2B7(16); 2C1(3); 2C4(3); 2C5(1); 2C7(2); 3A4(4); 3A6(2); 3A7(2); 3B5(14); 3B6(12); 3B7(17); 3B8(1).

Upper Miocene to Recent. *H. minuscula,* one of the more common, widespread, and successful terrestrial species in North America, lives in nearly any terrestrial habitat.

Table I.—Comparison of molluscan faunules from stations one, two, and three, Caddo and Canadian Counties, Oklahoma

Species	Station One		Station Two		Station Three		Now Present
	No.	%	No.	%	No.	%	
Sphaerium striatinum			14	2.55			yes
Sphaerium transversum			2	0.36	14	1.91	yes
Pisidium casertanum			17	3.10	108	14.79	yes
Pisidium compressum	10	2.25	14	2.56			yes
Pisidium nitidum			32	5.85			?
Pomatiopsis lapidaria					9	1.23	?
Lymnaea palustris	1	0.23	2	0.36			no
Lymnaea bulimoides					2	0.27	yes
Lymnaea caperata					4	0.55	no
Lymnaea humilis (dalli)	2	0.45	6	1.08	102	13.97	yes
Lymnaea humilis (obrussa)	1	0.23					yes
Lymnaea humilis (parva)	1	0.23	2	0.36			yes
Lymnaea humilis (humilis)			1	0.17	60	8.22	yes
Gyraulus circumstriatus	2	0.45	11	2.06	6	0.82	no
Gyraulus parvus	294	66.21	96	17.57			yes
Helisoma anceps	13	2.92	9	1.64			yes
Helisoma trivolvis	11	2.48	7	1.27	12	1.64	yes
Ferrissia meekiana			5	0.91			no
Laevapex fuscus	1	0.23					yes
Physa anatina	43	9.68	41	8.05	18	2.46	yes
Physa gyrina	20	4.50	13	2.37			yes
Physa skinneri					9	1.23	no
Carychium exiguum			16	2.92	38	5.20	yes
Strobilops labyrinthica			12	2.20	12	1.64	yes
Strobilops lonsdalei					34	4.66	no
Strobilops sparsicostata			3	0.54			no
Gastrocopta cristata	1	0.23	2	0.36			yes
Gastrocopta procera			11	2.00			yes
Gastrocopta pellucida	2	0.45	1	0.17	1	0.15	yes
Gastrocopta armifera	3	0.67	13	2.37	10	1.37	yes
Gastrocopta contracta			3	0.54	7	0.96	yes
Gastrocopta falcis					1	0.15	no
Gastrocopta tappaniana			14	2.55	47	6.44	yes
Pupoides albilabris	2	0.45	4	0.72	1	0.15	yes
Pupoides inornatus			1	0.17			no
Vertigo ovata	1	0.23			2	0.27	yes
Vallonia gracilicosta	1	0.23					no
Vallonia parvula	5	1.12	7	1.27	3	0.41	yes
Succinea concordialis			26	4.75			yes
Catinella vermeta	1	0.23	13	2.37	30	4.11	yes
Oxyloma retusa					1	0.15	yes
Helicodiscus parallelus	1	0.23	7	1.27	4	0.55	yes
Helicodiscus singleyanus	3	0.67	5	0.91	1	0.15	yes
Helicodiscus nummus			3	0.54			yes
Anguispira alternata					2	0.27	yes
Deroceras laeve			1	0.17	1	0.15	yes
Deroceras aenigma			2	0.36	5	0.68	no
Euconulus fulvus	1	0.23			2	0.27	yes
Nesovitrea electrina					55	7.53	yes
Retinella indentata	2	0.45	36	6.58	48	6.57	yes
Pilsbryna tridens					2	0.27	?
Hawaiia minuscula	11	2.48	48	88.78	52	7.12	yes
Zonitoides arboreus	4	0.90	28	5.12	6	0.82	yes
Striatura milium			2	0.36			yes
Mesodon sp.					6	0.82	yes
Stenotrema leai leai	7	1.57	16	2.92	15	2.05	no
Totals	444		546		730		

Zonitoides arboreus (Say)

Collections: 1A10(2); 1A11(2); 2A6(2); 2A8(1); 2B3(3); 2B5 (3); 2B6(2); 2C1(7); 2C2(5); 2C7(4); 2C9(1); 3A5(6).

Lower Pliocene to Recent. Although *Z. arboreus* is widespread, it is usually considered as a forest or marginal-forest species, being more common near moisture-conserving bodies.

Striatura milium (Morse)

Collections: 2B8(2).

Upper Pleistocene to Recent. A fairly common mollusk in eastern Oklahoma and the northern United States, it is exceedingly small and lives in moist forest floor humus (Pilsbry, 1946). It is a rare form in Pleistocene deposits but is easily recognized by its beautiful cross-hatched sculpture and small size.

Polygyridae

Mesodon sp.

Collections: 3A4(3); 3A6(1); 3A7(1); 3B5(many pieces); 3B6 (1).

Upper Pleistocene to Recent. Most species of *Mesodon* have relatively high moisture requirements and are mycophagous. Consequently, most of them are found in eastern and northern United States. However, at least one species, *Mesodon thyroidus* (Say), utilized the marginal forests of streams to extend its range westward (Branson, 1959a). LaRocque (1952) found *Mesodon clausus* (Say), a species which has some tolerance for hot weather, in an Ohio Pleistocene deposit. None of the presently reported specimens was in good enough shape to allow specific identification.

Stenotrema leai leai (Binney)

Collections: 1A4(1); 1B2(1); 1C3(4); 1C10(1); 2A4(1); 2A8(1); 2B1(1); 2B2(13); 3B5(10); 3B6(5).

Middle Pleistocene to Recent. *S. l. leai* was replaced in Recent time by *S. l. aliciae*, which has a nearly completely closed umbilicus. The latter race inhabits the moist marginal forests of streams and ponds.

Polygyridae fragments.

Collections: 1C5(1); 2A7(1); 3B8(1).

These fragments could not be assigned to a genus but they have the sculpture and general lines of this family.

Many unidentifiable fragments were found in all collections except 3B1, which contained nothing. A single fragment of some herbaceous plant was taken from 2A5, and the left mandible of *Peromyscus* sp. was found at 1B10.

CONCLUSIONS

The presence of several species characterizing cooler and more northern areas makes it seem likely that the faunules herein described lived during cool glacial times rather than in interglacial ones. Several of the species usually associated with the Illinoisan are present, whereas those characteristic of the Wisconsinan are, in general, absent.

Western Oklahoma is rich, perhaps more so than any other single region, in Pleistocene terrestrial and aquatic mollusks, fishes, and some mammals. This is probably accounted for by the absence of an ice cap and because the streams during glacial epochs carried large loads of silt from the north. Much additional field work needs to be done in this part of the State.

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Extent of the Dolman Member of the Hoxbar Formation

E. A. Frederickson

The Dolman Limestone was given formational rank when first named by Westheimer and Schweers (1956, p. 146-147) for two limestone units encountered in wells in the Southwest Lone Grove Field in T. 5 S., R. 1 W. The limestones were about forty feet apart and approximately 250 feet below the Anadarche Limestone.

According to Westheimer and Schweers, "the upper member, generally 5-10 feet thick, is an amber-colored, generally finely arenaceous, fossiliferous limestone . . . . The lower limestone, about 20 feet thick, is finely sucrose, white to buff, and generally contains crinoid fragments."

Frederickson (1957b, p. 73) reported a limestone sequence in the same stratigraphic position, i. e., between the Crinerville Limestone and Anadarche Limestone, in the Brock anticline in T. 5 S., R. 1 E., and assigned the limestone unit to the Dolman Member of the Hoxbar Formation. He also showed the outcrop pattern of the limestones on the geologic map of the Criner Hills (Frederickson, 1957a).

Walker (1959, p. 250) identified the Dolman Limestone Member in wells in the West Brock Oil Field. In the generalized stratigraphic section (p. 252, fig. 2), he described the upper bed as dark-gray and brown-mottled sandy limestone, and the lower bed as tan, crinoidal limestone.

In 1960, Harlton used the term Dolman Formation for a succession of fusulinid-bearing limestones, sandy limestones, shales, and sandstones in the Cement pool area. This sequence was encountered between units which Harlton correlated with the Anadarche and Crinerville Members of the Hoxbar Formation.

A thin limestone sequence, heretofore unreported, occurs between the outcrops of the Anadarche and Crinerville Limestones in the trough of the Pleasant Hill syncline in NW¼ SW¼ sec. 14, T. 5 S., R. 1 E. The beds are 250 feet below the Anadarche Member and about 400

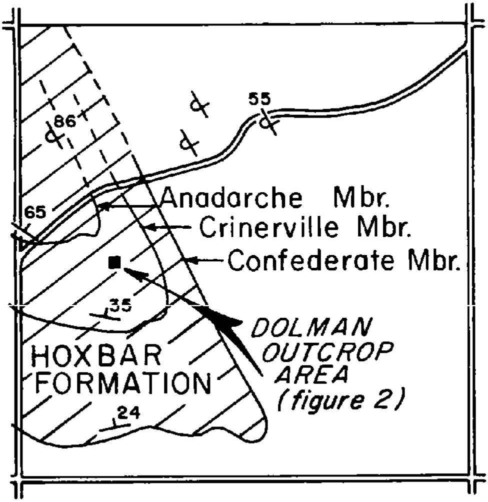

Figure 1. Generalized geologic map of sec. 14, T. 5 S., R. 1 E., showing stratigraphic and structural position of the Dolman outcrops in the Pleasant Hill syncline.

feet above the Crinerville Member. The thin limestones are extremely broken by faulting and the outcrop is limited in areal extent. This sequence crops out discontinously at the south end of the east flank of the Pleasant Hill syncline (figs. 1, 2), where it is cut by several small faults. Because this is the best exposure of the Dolman Member thus far found in the Ardmore basin, it is proposed to make this the type section. A description follows:

DOLMAN MEMBER OF THE HOXBAR FORMATION

(Section measured with jacob staff, just west of old wagon trail in NW¼ SW¼ sec. 14, T. 5 S., R. 1 E.)

	Feet
1. Limestone, argillaceous, fine- to medium-crystalline, tan, crinoidal, fossiliferous. Six-inch bed at top, beds 1 to 2 inches at base	1.0
2. Covered zone, shale?	1.5
3. Limestone, argillaceous, fine-grained, tan, fossiliferous. Beds range from 1 to 4 inches in thickness. Unit becoming increasingly argillaceous toward base	3.5
Total	6.0

A smaller exposure of the Dolman Limestone occurs in the center of the Brock anticline NE¼ NW¼ sec. 20, T. 5 S., R. 1 E. The unit is approximately four feet thick and the limestone is medium crystalline, tan, crinoidal, and arenaceous, in contrast to the argillaceous character of the limestone in the Pleasant Hill syncline.

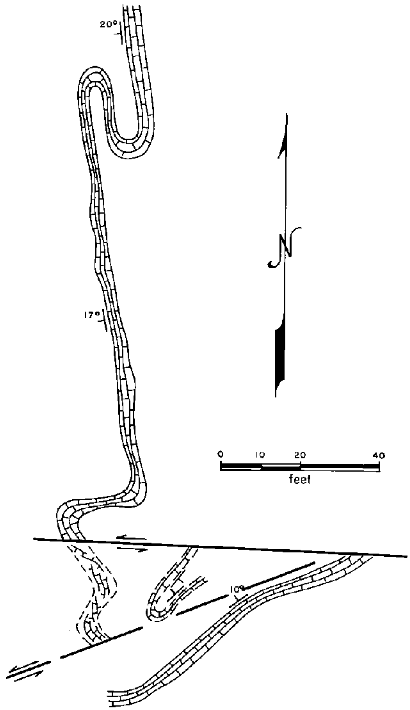

Figure 2. Outcrop map of the Dolman Member at the south end of the east flank of the Pleasant Hill syncline as defined by the exposures of the Confederate and Crinerville Members, NW¼ SW¼ sec. 14, T. 5 S., R. 1 E.

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Helminthochiton FROM THE PENNSYLVANIAN OF OKLAHOMA

E. A. FREDERICKSON

INTRODUCTION

The fossil chiton described in this paper was collected by William Riddle, a student at The University of Oklahoma, while on a field trip with the paleontology class. He kindly presented the specimen to the university collection.

The chiton was collected from the shale exposure of the lower part of the Francis Formation in the quarry of the brick plant on the southwest edge of Ada, Oklahoma, in NE¼ SE¼ sec. 4, T. 3 N., R. 6 E. The Francis Formation is Missourian (Upper Pennsylvanian) in age.

The fauna of the Francis Formation has been listed by Morgan (1924, p. 116-118), as including the following more abundant forms:

Lophophyllidium profundum
Echinocrinus sp. (isolated plates and spines)
Crurithyris planoconvexa
Chonetes granulifer
Kozlowskia splendens
Linoproductus prattenianus
Neospirifer dunbari
Astartella vera
Ameura major

The Francis Formation as exposed in the quarry is a dark-gray to black shale and mudstone which weathers in a blocky fashion. An abundant assortment of fossils is present which represents a diverse assemblage of shallow-water forms. Crinoid fragments are especially abundant, including numerous dorsal cups and a few complete crowns. Unfortunately, most of the specimens have been crushed or flattened and indurated, or leached of much of the calcium carbonate of the

Figure 1. Holotype of Helminthochiton riddlei, **new species, x3.5.**

skeleton. Upon exposure, many specimens break into fragments. Fortunately, the chiton specimen was preserved intact, although the calcium carbonate of the shell was leached away.

Fossil chitons have been reported from numerous localities in Tertiary strata in North America, but Paleozoic forms are rare. Most Paleozoic genera have been reported from Europe, but a few species are known from the Paleozoic of North America. Among these are *Prisochiton canadensis* (Billings) from the Ordovician of Canada, *Helminthochiton parvus* (Stevens) from the Mississippian of Indiana, and *Helminthochiton carbonarius* (Stevens) and *Helminthochiton concinnus* Richardson from the Pennsylvanian of Illinois.

According to Smith (1962, p. I47), the total number of species of fossil chitons is approximately 350, with 73 species known from the Paleozoic. Fossil chitons are normally known only from the disarticulated valves, but in a few instances all eight valves have been found together.

In North America, the Ordovician form from Canada, *Prisochiton canadensis,* is known from two head valves. The specimens from Illinois are unique in that they are complete skeletons having all eight valves. The Oklahoma specimen is also a rarity because six of

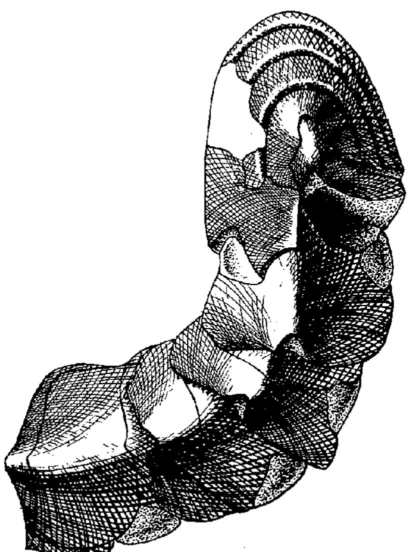

Figure 2. Helminthochiton riddlei, **new species. Drawing of the holotype, x5, showing six preserved valves, anterior and intermediate valves** ii **to** vi.

the eight valves are in a continuous series, and also because it is the first fossil specimen of the class Amphineura to be found in Oklahoma.

The genus *Helminthochiton,* to which the Oklahoma specimen is assigned, ranges from Lower Ordovician to Pennsylvanian in age. The genus has been reported from Indiana (Mississippian) and Illinois (Pennsylvanian) in North America and from Scotland (Ordovician), Czechoslovakia (Ordovician), Ireland (Silurian), Belgium and the U. S. S. R. (Lower Carboniferous).

Morphological characteristics of *Helminthochiton* notable in the Oklahoma chiton are the distinct jugal angle, widely separated sutural laminae, subquadrate intermediate valves and the absence of insertion plates.

The Oklahoma specimen has the anterior plate and five median plates preserved; the two posterior plates are missing. The six plates

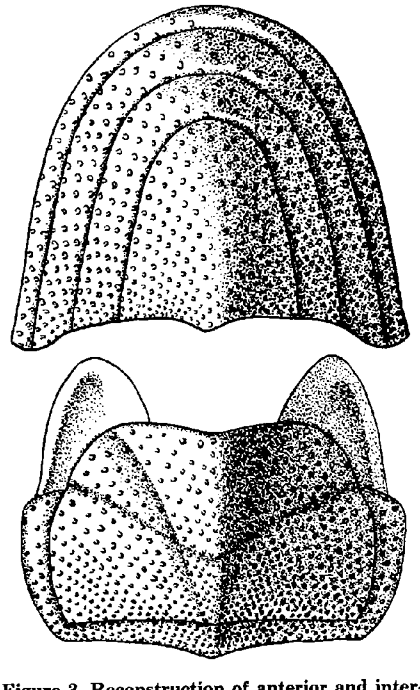

Figure 3. Reconstruction of anterior and intermediate valves of Helminthochiton riddlei, **new species.**

Above: Anterior valve, x10.
Below: Intermediate valve vi, **x10.**

are articulated and partly crushed. The shell is 20 mm long and 6 mm wide; presumably the complete animal was about 27 to 28 mm long. The posterior portion of the anterior valve is broken away so that the nature of the beak is not known. The sixth valve is uncrushed and well preserved, showing excellently the features of the median valves. Sutural laminae of the third, fourth, fifth, and sixth valves are exposed on the right side of the specimen where the valves have slid away from one another because of the axial bending; and the left sutural lamina of the second valve is revealed where the anterior valve is broken away.

Classification and morphological terms used in this paper are after Smith (1960).

SYSTEMATIC DESCRIPTION

Phylum Mollusca
Class Amphineura
Suborder Lepidopleurina
Order Neoloricata
Suborder Lepedopleurina
Family Lepidopleuridae

Genus *HELMINTHOCHITON* Salter, 1846
Helminthochiton riddlei, new species

Figures 1-3

Description.—Anterior valve semioval, longer than wide. Front and sides of valve slope regularly upward; trend of slope indicates probable posterior beak; however, rear portion of valve is not preserved. Valve with narrow border and marginal furrow; two depressed concentric growth lines on valve slope inside border.

Intermediate valves subquadrate, mucronate, wider than long; rounded anteriorly. Central ridge (jugum) prominent, sharp, with slight constriction at center of each valve. Apex at posterior margin of valves, slightly depressed and overlapping succeeding valve.

Intermediate valves *ii* to *v* with distinct trangular hump in anterior one-fourth of valve; depression on jugal angle at apex of posterior pointing triangle. Triangular hump shaped to fit under beak of preceding valve, possibly to aid in articulation. Indistinct hump on intermediate valve *vi*.

Lateral areas flatly concave with shallow trough defining junction with central area. Valves with narrow, raised, convex border separated from lateral area by furrow; border flattened and depressed around posterior margin of valves. Growth lines lacking.

Sutural laminae widely separated, smooth, unslit, broad at basal attachment to anterior-lateral valve margin; shaped like rounded right triangle. Sinus broad.

Ornamentation of all valves consisting of small granules arranged in quincunx over entire surface; no change of ornamentation between central and lateral areas.

Remarks.—Ornamentation of *Helminthochiton riddlei* differs in the quincuncial arrangement of the tubercles which are concentrically arranged in *H. carbonarius* and *H. concinnus,* the two other American Pennsylvanian chitons belonging to this genus. The presence of the border around the valves in *H. riddlei* and the triangular hump on the anterior of the median valves are distinctive.

Holotype.—The type consists of one specimen, OU 735, in the collection of The University of Oklahoma, School of Geology.

Locality.—Francis Shale, brick plant quarry, southwest of Ada, NE¼ SE¼ sec. 4, T. 3 N., R. 6 E.

Bibleography

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Late Paleozoic Fossils of Montana

Carl C. Branson

A few months ago I borrowed Drake's types of Oklahoma fossils from Stanford University through the good offices of Dr. Myra Keene. These were photographed by William H. Bellis and a short paper was prepared by me. This paper was issued on September 10, 1962. During August a monograph by W. H. Easton was received in which the types of one of Drake's species were figured and the holotype of another was described. Easton's figures of *"Marginifera" adairensis* Drake are plate 8, figures 19a-e, a specimen selected by Easton (and later by me) as holotype, and figures 20a-b. The species was placed in the genus *Inflatia* by Muir-Wood and Cooper and in *Kozlowskia* by me. Easton also redescribed the holotype of *Productus cherokeensis* Drake (p. 53-54), as I did in my paper, a species considered by him to be a variety of *"Dictyoclostus" inflatus,* by me to be a species of *Inflatia.*

Easton's monograph was completed before 1957 (see footnote on p. 20), a fact which accounts for his several outmoded generic assignments. His work describes Mississippian and Pennsylvanian fossils of central Montana. Some of these out-of-date generic assignments are:

Productus fasciculatus McChesney = *Diaphragmus*
Linoproductus croneisi Branson = *Ovatia*
"Dictyoclostus" inflatus (McChesney) = *Inflatia*
"Dictyoclostus" richardsi (Girty) = *Protoniella*?
"Marginifera" planocosta n. sp. = *Kozlowskia*?
Allorisma walkeri Weller = *Wilkingia*
Allorisma inflata(um) = *Wilkingia*

In the reviewer's opinion *Conocardium glabratum* n. sp. is a steinkern and probably not a new species.

The important monograph loses much of its impact by delay in publication. The field of paleontology progresses too rapidly for such a paper to be delayed five or more years in publication.

References

Branson, C. C., 1962, Type specimens of two Oklahoma Mississippian brachiopods: Okla. Geol. Survey, Okla. Geology Notes, vol. 22, p. 240-244.

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Biennial Geological Symposia

The eighth biennial geological symposium, sponsored by the School of Geology and the Department of Business and Industrial Services, Extension Division, The University of Oklahoma, will be held March 5 - 6, 1963. Groups participating will be the Oklahoma Geological Survey, the Ardmore Geological Society, the Panhandle Geological Society, and the North Texas Geological Society. Dr. Louise Jordan, geologist with the Oklahoma Geological Survey, will serve as chairman, taking the place of Dr. Carl A. Moore, who is with the Peace Corps in Bolivia.

Published proceedings of the seven previous symposia include:

1949—First Biennial Symposium, *Subsurface Logging Techniques,* 13 articles, 113 pages.

1951—Second Biennial Symposium, *Subsurface Geological Techniques,* 13 articles, 143 pages.

1953—Third Biennial Symposium, *Subsurface Geology,* 10 articles, 94 pages.

1955—Fourth Biennial Symposium, *Subsurface Geology,* 10 articles, 115 pages.

1957—Fifth Biennial Symposium, *Carbonate Reservoirs,* 10 articles, 167 pages.

1959—Sixth Biennial Symposium, *Mississippian System in Mid-Continent Region,* 10 articles, 175 pages.

1961—Seventh Biennial Symposium, *The Arkoma Basin,* 14 articles, 234 pages.

Copies of proceedings of symposia held in 1953, 1957, 1959, and 1961 may be obtained from the Business and Industrial Services, Bldg. 4, South Base, The University of Oklahoma. $5.00 per copy.

Note on Age of Union Valley Cephalopod Fauna

James H. Quinn

Subsequent to publication of the report by Quinn (1962) it was discovered (p. 119) that the rocks at the "recently discovered locality in Washington County, which appears to be of Kessler age," actually lie 27 feet below the Baldwin coal. Because the data for the Kessler column of the chart (fig. 2) were drawn chiefly from this locality, it is probably in error. No other evidence of occurrence of *Proshumardites* in Kessler strata is known.

We have also discovered that *Gastrioceras grileyi* occurs and *Pygmaeoceras* is most abundant at the Gaither Mountain locality. *Cravenoceras*? *morrowense* is rare there. Miller and Moore mistakenly associated *Pygmaeoceras* with *Cravenoceras*? as small specimens of that genus.

For the present the Kessler column of figure 2 (Quinn, 1962) should be disregarded.

Reference Cited

Quinn, J. H., 1962, Age of Union Valley cephalopod fauna: Okla. Geol. Survey, Okla. Geology Notes, vol. 22, p. 116-120.

Erratum and Apology

In writing an article for the Notes (vol. 22, p. 251) I carelessly failed to check my correspondence to alert my memory. The gentleman who found **Conostichus** in northeastern Kentucky, lent me specimens, and devoted a day to taking me to the localities is Richard A. Sheppard. I offer him an apology and renewed thanks.

—C. C. B.

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Volume 22 November 1962 Number 11

In This Issue