A Pleistocene Molluscan Fauna Near Byers, Clay County, Texas[1]

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ABSTRACT

Fossil fresh-water and land mollusks are described from a Pleistocene alluvial deposit near Byers, in Clay County, Texas—an ancient lake-bed formed by an ox-bow cut-off during the meandering of the Red River. Using as indicators recognized faunas which are identified with known geological ages in the mid-continent region of the United States, a comparative study chart and vertical-range graph were made of the Byers shells to determine age of deposition. This comparative-study method dated the shell deposit back to an Illinoian age. The molluscan fauna indicates during this time a more humid and cooler climate without the summer high temperatures which prevail in the same area today.

INTRODUCTION

Only during the past few decades have paleontologists directed their efforts toward the study and correlation, through faunal association, of the Pleistocene deposits of the non-glaciated areas of the United States. The discovery of late Pliocene and Pleistocene fossil deposits in Kansas in 1936, and the subsequent work of C. W. Hibbard (1938 to 1958), F. C. Frye (1941 to 1942), D. S. Franzen (1942 to 1947), A. B. Leonard (1948 to 1952), H. B. Herrington (1954 to 1958), and D. W. Taylor (1954 to 1960), and others in Kansas, Oklahoma and Nebraska, have provided a working basis whereby large areas may be correlated geologically. In Texas, only isolated localities in widely separated areas have been studied, and efforts to correlate faunal assemblages with glacial stages in Texas have been handicapped by a lack of published data. Many localities, therefore, are described as of Pleistocene age; but few attempts have been made to place these deposits in their proper glacial or interglacial stage.

In Texas, as well as in other parts of the United States, many of the deposits which contain fresh-water and terrestrial mollusks have

[1] We are indebted to Dr. Walter W. Dalquest of Midwestern University for calling attention to the site, and for collecting many of the shells used in this study. His suggestions concerning the interpretation of the aerial map (fig. 2) are also greatly appreciated. We are also indebted to Mrs. Paul Dowdy, the land owner, for permitting access to the shell deposit, and to Mr. H. F. Lovorn, for help in collecting.

few, if any, vertebrate remains. Since fossil vertebrates have been used primarily to date Pleistocene deposits, the use of fossil shells as indicators in marking geological periods may be extremely important, especially when vertebrate remains are either absent or meagre and fossil shells abundant. Thus, the shells would serve a two-fold purpose—as indicators to date geological deposits, and as aids to paleoecological studies.

With this in mind, and in the previous lack of adequate data from Pleistocene deposits in Texas comparable with those gained in the States above mentioned (especially as regards the geographical and temporal distribution of molluscan species), we have studied the fossil assemblages of the Byer locality in Clay County, Texas. This assemblage gave a basis of comparison and correlation with those of other areas in the mid-continent region of the United States.

In the past, many species of terrestrial shells now extinct have been used as indicators in faunal dating, especially when the time-span was over a longer period than the 1,000,000 years estimated as maximum for the Pleistocene. Geologically, a million years is a short time for apparent molluscan evolution, and the Pleistocene molluscan shells show little change in form and structure over similar time-periods. Data now available seem to show that only a few species of mollusks made their first appearance in the Pleistocene, and that but few became extinct during the latter part of this period. Vertebrates have been more useful in faunal-dating because of the more apparent rapid evolution in their osteological structures. The evolution and extinction of some species of vertebrates have been rapid enough to provide well authenticated index-fossils.

Land snails are greatly affected by severe or prolonged temperature-changes. Van Cleave (1931) stated that in the drought of 1930 in a southern Illinois hardwood tract, an estimated 99% of the land snails was eradicated. Land and fresh-water mollusks doubtless were affected by the climatic changes of the glacial and interglacial stages; and many disappeared from areas no longer suitable for their propagation and growth. The pronounced temperature changes of the glacial and interglacial stages are quite apparent through the shifts of population and faunal mixing in fossil assemblages. For this reason, the periods represented by the glacial and interglacial stages can be correlated with the fossil assemblages through the ecological requirements of the fauna as a whole. In the mid-continent region

of the United States, a nearly complete sequence of late Pliocene and Pleistocene faunas has been recorded. Since these faunas are found in restricted areas, all within the Eastern Division (Fig. 1) of the molluscan provinces (Henderson, 1931), they could very well serve as comparative faunas for the study of the Byers local fauna. Because of our incomplete knowledge of fossil fresh-water and land shells

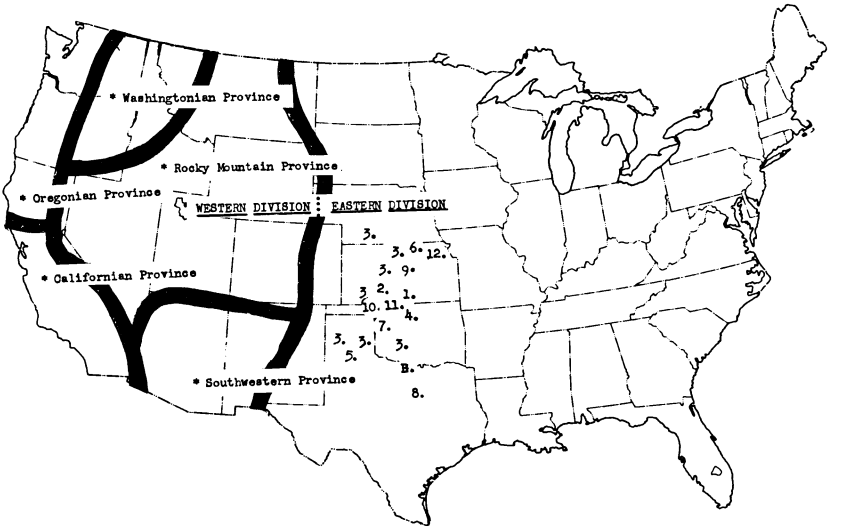

FIG. 1. Molluscan Divisions and Provinces in the United States; Location of Comparative Faunas: 1, Dixson Local Fauna; 2, Sanders Local Fauna; 3, Pearlette Ash Fauna; 4, Berends Fauna; 5, Texas High Plains Fauna; 6, Crete-Loveland Fauna; 7, Bar-M Fauna; 8, T-2 Terrace (Shuler) Fauna; 9, Rezabek Local Fauna; 10, Jinglebob Fauna; 11, Jones Fauna; 12, Peorian Faunas; B, Byers Local Fauna.

in the north-central Texas area, information for comparative studies must come from more distant sources than is desirable; therefore, the element of distance between Byers and the test faunas might contribute to possible error. Where this method of dating has been tried, however, interesting results have been obtained.

Many small creek and river terrace deposits in Texas considered of Pleistocene age contain abundant mollusks, while the vertebrate remains are either meagre or lacking. Our area near Byers, in Clay County yields a rich molluscan fauna, but lacks the vertebrate fauna needed for accurate geological dating by accepted methods. In this instance, therefore, we are proposing a technique for determining glacial and interglacial stages by a comparison of the land and

fresh-water fossil shells of recognized molluscan faunas which occur in the mid-continent region with molluscan assemblages in geological deposits where indicator-fossil vertebrates are either sparse or lacking.

TECHNIQUE

Samples of the matrix containing the shells were collected in 100-pound bags from various exposures in the deposit. The matrix was then thoroughly dried, using care not to break the large pieces of matrix, and then put through the washing technique of C. W. Hibbard (1949).

DESCRIPTION OF THE LOCALITY

The Byers deposit is in a small erosional gully which, according to Dr. Dalquest, has probably been exposed within the past 50 years. It is located on the farm of Mrs. Paul Dowdy, three miles west of the town of Byers, in Clay County. The small lake (Fig. 2, a) northeast of the site is probably a remnant of a much larger lake that at one time covered the area under study. Through siltation this shallow lake was probably divided into separate ponds which were gradually filled, leaving only the small remaining lake.

The Pleistocene deposits of the area rest unconformably on Permian basal rocks and shales. The Permian substrate has not yet been exposed in the erosional gully which at present has reached a maximum cutting depth of 12 feet. A surface mask of red sandy-clay, containing some pebbles and flint chips that well may indicate the presence of early man in the area, overlies the fossil zone. Beneath the red sandy-clay (7 feet deep in places), lies the fossiliferous blue-gray clay. No apparent thinning of the faunule is evident on either side of the gully. Since in some places the width of the gully is more than 40 yards, and the depths of the deposit containing rich molluscan assemblage show little variation, the area covered by the original lake must have been extensive. The fossils are uniformly distributed throughout the blue-gray clay, and are not size-sorted as in stream deposits. The homogeneity of distribution is thereby interpreted as evidence of gradual silting, a characteristic of lake deposits. The molluscan fauna is in an excellent state of preservation. Only the presence of species now locally extinct, and the absence of the normal coloring usually present in recent shells, would lead an observer to believe the antiquity of the deposit.

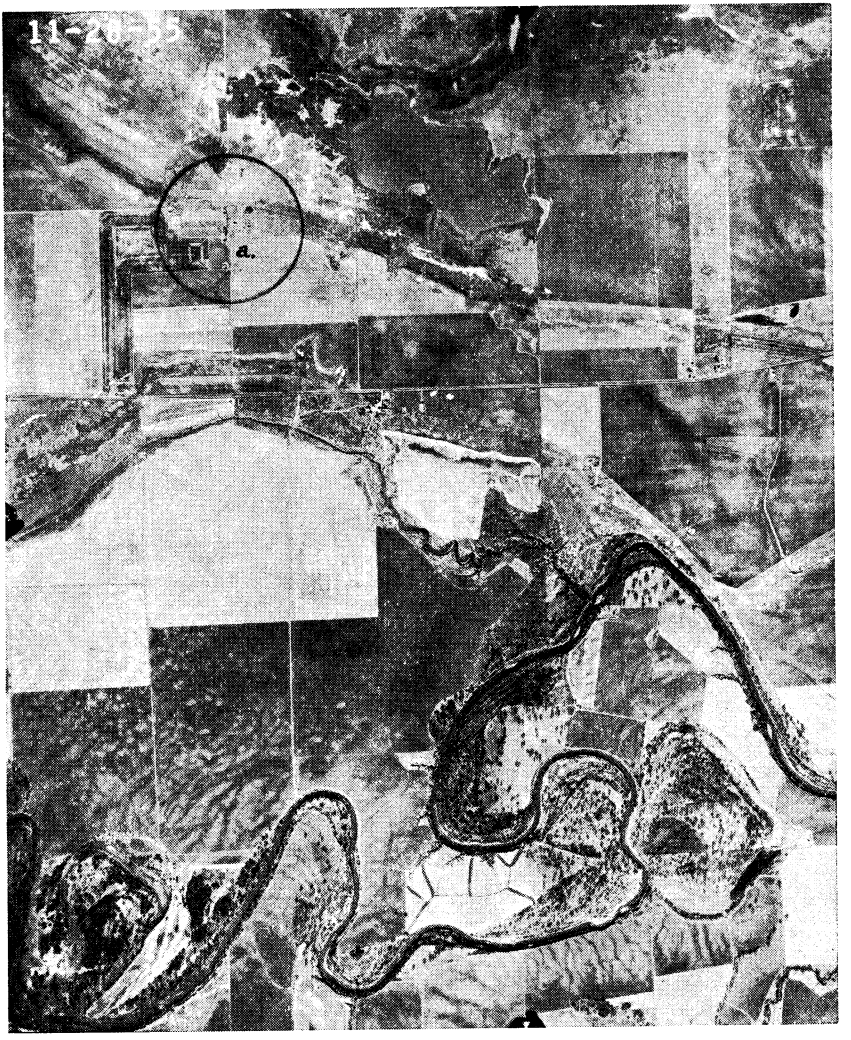

FIG. 2. Aerial Photograph of the Byers Deposit; *a* (in circle) is an erosional gulley.

Although fossil shells are abundant, the remains of only two vertebrates have been discovered to date. These consist of the remains of a disarticulated elephant in a very poor state of preservation, and the fragmentary incisor of an unidentifiable rodent. It was through the discovery of the elephant bones by school children living in the area that this locality was brought under study.

Tables 1-3, dealing with geographical and temporal distribution of molluscan species, and their ecology, are deferred to pages 162 to 167.

FAUNAL LOCALITIES USED FOR THIS COMPARATIVE STUDY

Dixon Local Fauna, Kingman County, Kansas (Nebraskan-Aftonian age). Frye & Leonard, 1952; Herrington & Taylor, 1958; Hibbard, 1956, 1958; Taylor, 1960; and Tihen, 1955.

Sanders Local Fauna, Meade County, Kansas (Late Aftonian age). Hibbard, 1956; Taylor, 1960; and Tihen, 1955.

Texas High Plains, Borden, Briscoe, Crosby, Garza, Lubbock, and Swisher counties (Kansan age). Frye & Leonard, 1957b.

Pearlette Ash Faunas, Northwestern Iowa, through Nebraska, Kansas and northwestern Oklahoma to northwestern Texas. Taylor (1960) suggests the name Cudahy for all the assemblages associated with the Pearlette ash, because of the contemporaneity of the associated faunas. Frye & Leonard, 1952; Herrington & Taylor, 1958; Hibbard, 1944, 1949b; Leonard, 1950; and Tihen, 1955.

Berends Fauna, Beaver County, Oklahoma (Illinoian age). Dwight W. Taylor, 1954; Herrington & Taylor, 1958; Hibbard, 1956; Mengel, 1952; Rinker & Hibbard, 1952; Smith, 1954, 1958; Starett, 1956; and Taylor & Hibbard, 1955.

Texas High Plains Faunas, Borden, Briscoe, and Dawson counties, Texas (Illinoian age). Frye & Leonard, 1957.

Crete-Loveland Molluscan Faunas, Jewel, Rice, and Jarton counties, Kansas (Illinoian age). A. B. Leonard, 1950.

Bar M Fauna, Harper County, Oklahoma (Illinoian age). Myers, 1959; Taylor & Hibbard, 1955; and Herrington & Taylor, 1958.

T-2 Terrace Fauna, Dallas County, Texas (Sangamon age). Slaughter *et al,* 1960.

Rezabek Fauna, Lincoln County, Kansas (Sangamon age). Hibbard, 1943; and Frye *et al,* 1943.

Jinglebob Fauna, Meade County, Kansas (Sangamon age). Herrington & Taylor, 1958; Hibbard, 1955, 1956; Oelrich, 1953; Rinker, 1949; Taylor & Hibbard, 1955; Tihen, 1954, 1955; and van der Schalie, 1953.

Jones Local Fauna, Meade County, Kansas (Wisconsinan age).

Downs, 1954; Franzen & Leonard, 1947; Frye & Hibbard, 1941; Goodrich, 1949; Herrington & Taylor, 1958; Hibbard, 1940, 1942, 1943; Taylor & Hibbard, 1955; and Tihen, 1942, 1955.

Peorian Molluscan Faunas, Eastern Kansas (Wisconsinan age). A. B. Leonard, 1952.

EXPLANATION OF THE VERTICAL RANGE CHART (Table 2)

This chart compares the mid-continent molluscan species with those appearing in the Byers deposit. If a Byers species has been noted from one of the comparative faunas, it is indicated on Table 2 under the geological age of the deposit in which it occurred.

Many of the Byers species are more hardy and less affected by climatic changs because they appear in the comparative faunas from Nebraskan to Wisconsinan time. Three species, *Euconulus fulvus, Stenotrema leai, and Succinea ovalis,* make their first appearances in the study area in the Kansan faunas; *Lymnaea exilis* and *Gyraulus circumstriatus* first appear in the Illinoian faunas; *Pomatiopsis lapidaria* is the only species, we believe, which has not been recorded from Pleistocene deposits in the mid-continent region. Although Baker (1902) recorded this species from the Pleistocene, he did not give the locality. *Strobilops sparsicosta* appear last in the Crete-Loveland fauna, where it apparently became extinct (Leonard, 1952); *Physa gyrina, Oxyloma retusa, Planorbula armigera,* and *Gyraulus circumstriatus* appear last in the mid-continent region during the Sangamon. *Nesovitrea electrina,* by our records, is not present in Texas today, but appears in Wisconsin faunas in the mid-continent region.

All species that occur in the Byers local molluscan fauna were present by Illinoian times in other molluscan local faunas recorded from the areas studied. If, therefore, the same species occupied north-central Texas at the time they occupied the mid-continent region, the Byers deposit could not well be dated earlier than Illinoian times.

By the end of the Illinoian stage, *Strobilops sparsicosta* disappeared from the faunas of the mid-continent region. If this extinction also occurred simultaneously in north-central Texas, then the Byers deposit would not be younger than Illinoian. Lending evidence to the premise that the Byers deposit is not younger than Illinoian is the fact that fossil shells of *Helicina orbiculata tropica* and *Bulimulus*

dealbatus (both present in Sangamon deposits in north-central Texas) are not present in the Byers site, although both are well represented as living species in the Byers vicinity.

CLASSIFICATION, DISTRIBUTION AND ECOLOGY

Phylum Mollusca
Class Gastropoda
Subclass Streptoneura
Order Ctenobranchiata
Family Pomatiopsidae

POMATIOPSIS LAPIDARIA (Say)

Present distribution.—"New York to Iowa, Michigan and Wisconsin south to Missouri, Alabama, and Georgia" (Baker, 1928).

Geologic range.—Pleistocene

Ecology.—*P. lapidaria* is an amphibious snail that prefers marshy areas of wet or moist ground where it lives among reeds and cattails, although the species is able to withstand periodic or seasonable droughts. Ameel (1938) stated the *P. lapidaria* can survive at least two months without water.

Shell measurements:

Length	*Width*	*Aperture length*	*Aperture width*	*Spire*
7.1	3.3	2.3	1.7	4.9
7.3	3.7	2.4	1.5	5.2
5.4	2.7	2.0	1.8	3.7
5.1	2.7	1.7	1.5	3.7
6.4	3.4	2.3	1.7	4.3

Remarks.—Considering the fact that this species is a gill-breather, it is remarkable that it can survive periods of drought by cutaneous respiration. This physiological adaptation is comparable to that found in terrestrial isopods, and could indicate an evolutionary change to the use of free atmospheric oxygen in respiration.

Subclass Euthyneura
Order Pulmonata
Suborder Basommatophora
Family Planorbidae

HELISOMA TRIVOLVIS (Say)

Present distribution.—"Atlantic coast and Mississippi River drain-

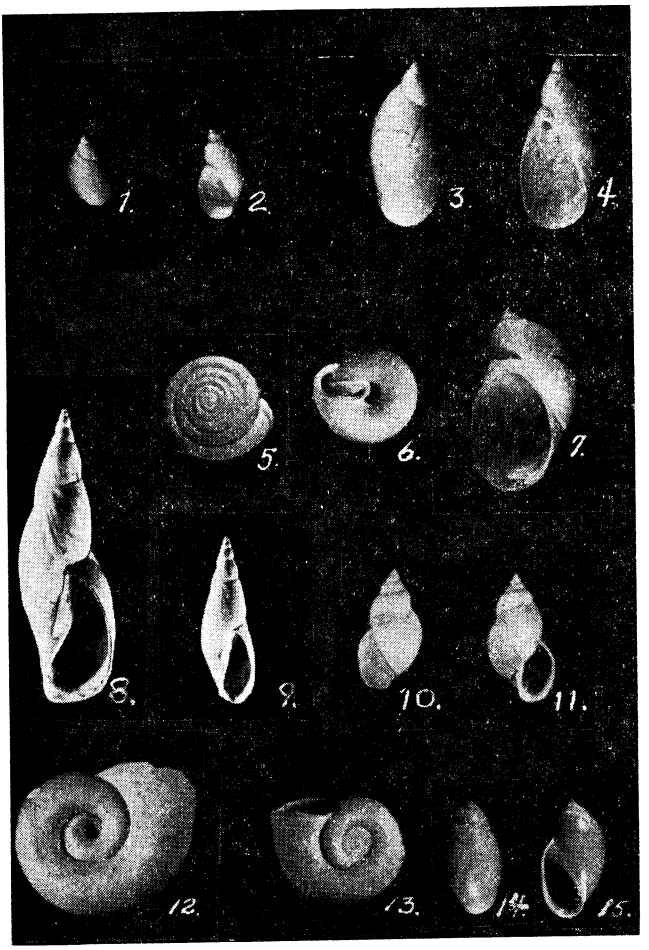

PLATE I. (all figures X 1.5)

1,2. Cf. *Succinea*, p. 155
3,4. *Oxyloma retusa* (Lea), p. 156
5,6. *Stenotrema leai* (Binney), p. 158
7. *Succinea ovalis* Say, p. 156
8,9. *Lymnaea exilis* (Lea), p. 150
10,11. *L. caperata* Say, p. 151
12,13. *Helisoma trivolvis* (Say), p. 144
14,15. *Physa gyrina* Say, p. 148

ages, northward to Arctic British America and Alaska and southward to Tennessee and Missouri. The southern distribution is not clear owing to the mixing with related species" (Baker, 1928). *Helisoma trivolvis lentum* is one of the subspecies which replaces *H. trivolvis* in Texas.

Geologic range.—Early Pleistocene (Dixon local fauna) to Recent.

Ecology.—Typical *H. trivolvis* and *H. lentum* usually do best in

quiet, more or less stagnant water with an abundance of algae. In a series of experiments conducted by Cheatum (1934) on the ability of certain species of aquatic pulmonate snails to withstand desiccation over prolonged periods, he found that 8 specimens of *H. trivolvis* out of 15 survived over a period of 62 days. All the snails which survived had burrowed into muck. This proves that even though *H. trivolvis* is usually associated with permanent water, it can adapt itself to meet such adverse conditions as temporary drought.

Shell measurements:

Diameter	*Depth*	*Aperture length*	*Aperture width*
14.8	7.6	8.2	7.4
18.2	7.2	7.5	7.2
13.0	7.2	6.5	6.8
12.9	7.3	6.7	6.1
15.1	7.3	7.7	7.3
13.9	6.9	8.0	6.9
11.9	6.4	6.9	5.9
11.2	5.8	5.9	5.7

Remarks.—*H. anceps,* often associated with *H. trivolvis* and *H. lentum,* is found most abundantly in creeks and rivers in clear running water. *Helisoma anceps* does not occur in the Byers local fauna. All of the recent species of *H. trivolvis* in our collection from Texas were identified by the late F. C. Baker as subspecies *lentum.* Shell variation in *H. trivolvis* is so pronounced in the Byers fauna that we are using a conservative taxonomic approach and are not attempting to place these shells in their subspecific rank.

GYRAULUS CIRCUMSTRIATUS (Tryon)

Present distribution.—"*G. circumstriatus* is found in a broad belt across central North America, in southern Canada and the northern United States between the Atlantic and Pacific Oceans; southward in the Rocky Mountains and thence to northern Arizona" (Taylor, 1960). This species is often confused with *G. parvus,* and consequently the exact limits of distribution are not known.

Geologic range.—Kansan (Cudahy faunas) to Recent.

Ecology.—*G. circumstriatus* is found in small seasonal bodies of water, such as ponds and marshes.

Shell measurements:

Diameter	*Depth*	*Aperture length*	*Aperture width*
3.0	1.5	1.2	1.3
3.6	1.0	1.6	0.8
2.9	0.9	1.2	0.7
2.8	0.7	1.0	0.6

Remarks.—Although *G. parvus* is found associated with *G. circumstriatus* in more or less permanent ponds and other waters, *G. parvus* is not found in waters that become seasonally dry. *Gyraulus parvus* is not found in the Byers deposit. To our knowledge, recent specimens of *Gyraulus circumstriatus* have not been reported from Texas. Leonard (1959) reports it as occurring in Kansas.

PLANORBULA ARMIGERA (Say)

Present distribution.—"New England west to Nebraska south to Georgia and Louisiana, north to Great Slave Lake" (F. C. Baker, 1928). No occurrence of recent shells has been recorded for Texas.

Geologic range.—Pleistocene to Recent.

Ecology.—*P. armigera* is an inhabitant of swales or of small and stagnant bodies of water (F. C. Baker, 1928).

Shell measurements:

Diameter	*Depth*	*Aperture length*	*Aperture width*
5.9	2.8	2.3	2.5
6.4	2.8	2.3	2.2
6.5	3.0	2.4	2.8
5.3	2.9	2.7	2.8
4.9	2.3	2.3	2.2

Remarks.—Most of the shells do not exhibit well developed apertural dentition; the lamellae, when present, show much variation in size and number. Consequently, this species has frequently been confused with other species. Shells of this species from the Byers locale were tentatively identified by D. W. Taylor (U.S. Geological Survey), who wrote as follows: "Neither set of *Planorbula* is *P. campestris or P. wheatleyi;* hence the species is *P. armigera* according to my present conservative approach." From a total of 187 shells which we examined, only 14 of the lot contained well developed apertural lamellae, and the variation in the lamellae is indicated in Plate 2. The range of variation in *P. armigera* shown in Plate 2 supports the statement made by Taylor (1960) that

"possibly *P. crassilabris,* Walker, *P. nebraskensis,* Leonard, *P. vulcanata,* Leonard, and *P. vulcanata occidentalis,* Leonard, are all synonyms of *armigera.*" Although the distributional range of this species includes Louisiana, we do not know of any listings of recent shells from Texas.

PROMENETUS UMBILICATELLUS (Cockerell)

Present distribution.—"North America north of about Lat. 41° from Nevada and Alaska east and southeast to western New York; south in the Rocky Mountains to southern Colorado; an isolated occurrence in the Ozark Mountains, Northeastern Oklahoma" (Taylor, 1960).

Geologic range.—Middle Pliocene to Recent.

Ecology.—"*P. umbilicatellus* prefers shallow marshy lakes with considerable vegetation of varied kinds. . . . *Helisoma trivolvis lentum* and large *Physa anatina* live in association there with *P. umbilicatellus*" (Leonard, 1959).

Shell measurements:

Diameter	*Depth*	*Aperture length*	*Aperture width*
3.1	1.3	1.2	1.2
2.8	1.2	1.1	1.1
3.1	1.2	1.2	1.0

Remarks.—To our knowledge there are no listings of recent shells of this species from Texas.

Family Physidae

PHYSA GYRINA (Say)

Present distribution.—*P. gyrina* has been recorded from the Arctic Regions south to Alabama and Texas. (Baker, 1928). To our knowledge, this species does not occur in Texas today. While many Late Pleistocene deposits in Texas contain fossil shells of the species, it has not been recorded from any of the sub-recent deposits studied in Texas.

Geologic range.—Nebraskan or early Aftonian (Dixon local fauna) to Recent.

Ecology.—*P. gyrina* thrives best in quiet waters and slow-flowing streams where abundant algal growths occur.

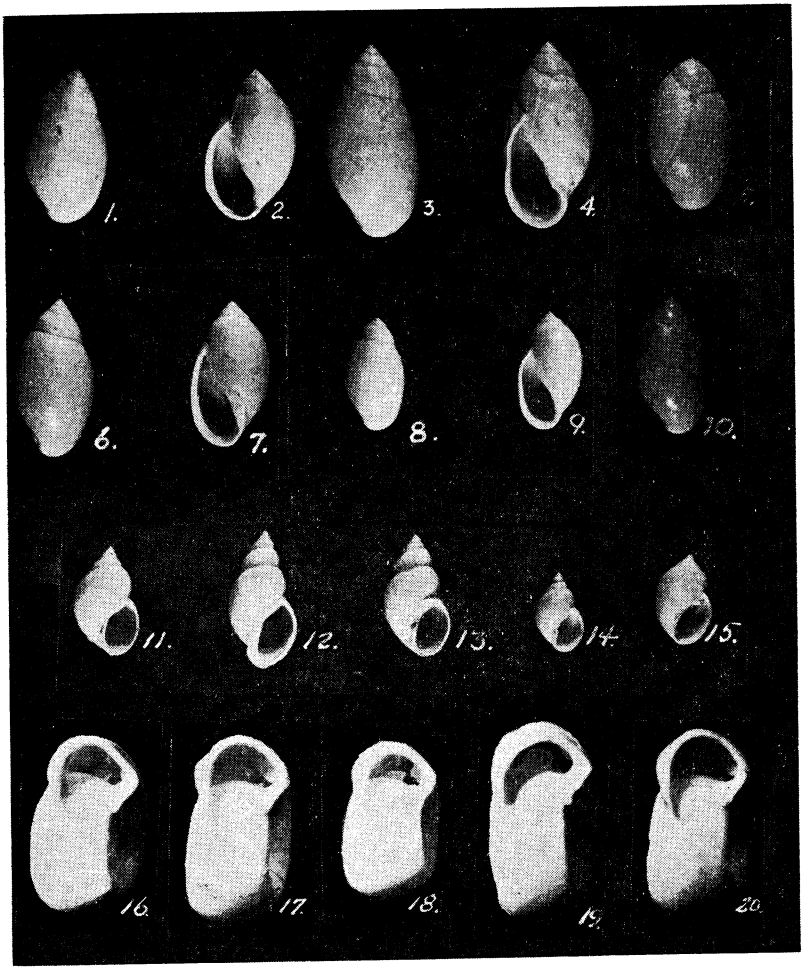

PLATE II. Variation in Shells

1-10 *Physa gyrina* (Say) (X 1.5), p. 148; 11-15, *Lymnaea caperata* Say, (X 1.0), p. 151; 16-20, *Planorbula armigera* (Say) (X 4.0), p. 147.

Shell measurements:

Length	*Width*	*Aperture length*	*Aperture width*	*Spire*
18.1	10.2	12.8	7.0	7.6
19.92	11.0	12.6	8.4	8.8
20.5	10.1	13.2	7.5	8.8
19.7	10.6	12.8	8.1	8.3
19.7	7.6	9.3	4.9	6.8
11.1	6.2	7.2	4.3	4.6

Remarks.—Dewitt (1955) observed that the young of Physa gyrina are capable of aestivating. Before the standing water had disappeared, the immature snails burrowed into the soft bottom, and remained there from mid-June until the pond filled in November. Periods of aestivation delay growth and attainment of sexual maturity. Perhaps the unusually large numbers of immature shells of fresh-water pulmonate snails in fossil assemblages elsewhere indicate temporary bodies of water. In many Pleistocene deposits, such as the T-2 Terrace deposit (Slaughter *et al.*, 1960) in Dallas County, where a summer-dry pond is evident, the vast majority of *Physa* shells are immature, and bear a close resemblance to *P. elliptica* in shape.

In the Byers locality the water supply was undoubtedly more permanent, and consequently *Physa gyrina* attained a large size. The variation in size and form is shown in Plate 2.

Family Lymnaeidae

LYMNAEA EXILIS (Lea)

Present distribution.—"Ohio to Kansas, northward to northern Minnesota and northern Michigan" (Baker, 1928).

Geologic range.—Pliocene (Rexroad) to Recent.

Ecology.—"*Exilis* is an inhabitant of sloughs, ponds and streams which dry up more or less during a portion of the year" (Baker, 1928). In a closely related species, *Lymnaea palustris,* Mozley (1932) reported that this snail formed an epiphragm over the aperture during the dry season. As far as we know this has not been reported for *L. exilis.*

Shell measurements:

Length	*Width*	*Aperture length*	*Aperture width*	*Spire*
26.3	7.2	11.7	5.0	15.7
20.6	7.5	10.5	3.5	11.3
16.7	6.6	7.8	3.7	10.7
29.9	8.5	12.8	4.5	13.0
17.8	6.5	8.7	3.7	11.2
17.6	6.2	8.0	3.6	10.3
31.6	10.5	15.0	7.3	18.5

Remarks.—Recent shells of this species have not been reported from Texas.

LYMNAEA CAPERATA (Say)

Present distribution.—"From Quebec and Massachusetts west to California; Yukon Territory and James Bay south to Maryland, Indiana, Colorado, and California" (Baker, 1928).

Geologic range.—Middle Pliocene (Buis Ranch local fauna) to Recent.

Ecology.—"This species seems to almost invariably occupy intermittent streams or small pools, ponds, and ditches which dry up in the summer" (Baker, 1928, p. 263).

Shell measurements:

Length	*Width*	*Aperture length*	*Aperture width*	*Spire*
11.4	6.0	5.4	3.2	6.9
13.5	6.3	6.3	4.4	7.7
11.7	5.9	5.0	3.0	7.5
10.5	6.6	6.2	2.8	6.4
8.7	5.4	4.9	3.2	4.7
7.3	4.6	3.7	2.5	4.0

Remarks.—Shell range in this species is rather unusual as indicated in Plate 2.

Suborder Stylommatophora
Family Strobilopsidae

STROBILOPS SPARSICOSTA (Baker)

Present distribution.—Extinct.

Geologic range.—Middle Pliocene to Illinoian (Leonard, 1952), where it becomes extinct. For an excellent description of this species, *see* Taylor, 1960. This species has been reported from fossil deposits in Texas, Oklahoma, Kansas and Nebraska.

Ecology.—Related species such as S. *labyrinthica* and S. *texasiana* prefer wooded areas where abundant moisture and decaying wood are present. These species are found associated with moist decaying vegetation, and it is assumed that S. *sparsicosta* had similar habits.

Shell measurements:

Length	*Width*	*Aperture length*	*Aperture width*
2.5	2.5	0.5	1.3
2.3	2.7	0.7	1.5
2.2	2.5	0.6	1.2

Remarks.—To our knowledge, *Strobilops texasiana* is the only species of this genus living in northern Texas today.

Family Pupillidae

GASTROCOPTA ARMIFERA (Say)

Present distribution.—"Eastern North America from southern Canada to Northern Florida, west to Alberta, Dakota, New Mexico" (Leonard, 1959). *G. armifera* is widely distributed over north-central Texas.

Geologic range.—Early Pliocene (Laverne local fauna) to Recent.

Ecology.—*G. armifera* is commonly found in wooded areas under leaf mold, rocks, and decayed wood. This species occurs in well-drained, as well as in very moist habitats wherever protection is afforded. In Texas we have found this species more abundantly associated with limestone rocks. Its movements are slow in comparison with those of most other pupillid species. Goodrich & van der Schalie (1944), in commenting on the genus *Gastrocopta*, state that "the species of the middle western area apparently all winter as eggs and in spring develop rapidly toward maturity." In the Dallas area the species *armifera* has been taken alive in midwinter, brought into the laboratory, and kept alive for several weeks.

Shell measurements:

Length	*Width*	*Aperture length*	*Aperture width*
3.6	1.2	1.3	1.3
3.5	2.1	1.3	1.3
3.8	2.1	1.3	1.3
3.5	2.0	1.3	1.3
3.0	1.8	1.4	1.3

Remarks.—*G. armifera* is the largest species of this genus in Texas. It is the least common of the pupillids found in the Sangamon and Illinoian deposits. Recent shells from the Dallas and Wichita Falls areas average over 4 mm. in length and *ca.* 3 mm. in width.

GASTROCOPTA TAPPANIANA (Adams)

Present distribution.—"Ontario and Maine to Virginia and Alabama, west to South Dakota and Kansas, southwest to Arizona, but not known from the southeastern Atlantic states, Virginia to Florida" (Pilsbry, 1948).

Geologic range.—Late Pliocene (Saw Rock Canyon local fauna, Rexroad local fauna, and Bender local fauna) to Recent.

Ecology.—"This snail is found beneath wood, logs, and similar debris

in moist places, especially on flood plains, and in moist upland forested areas" (Leonard, 1959). Sterki (1906) noted that the habits of *tappaniana* and *pentodon* are different. *G. pentodon* "is common among moss and grass in forest and on open slopes, even steep stony and rock hillsides, whereas *tappaniana* is hardly ever found. The latter is prevalent in low, damp places, under wood."

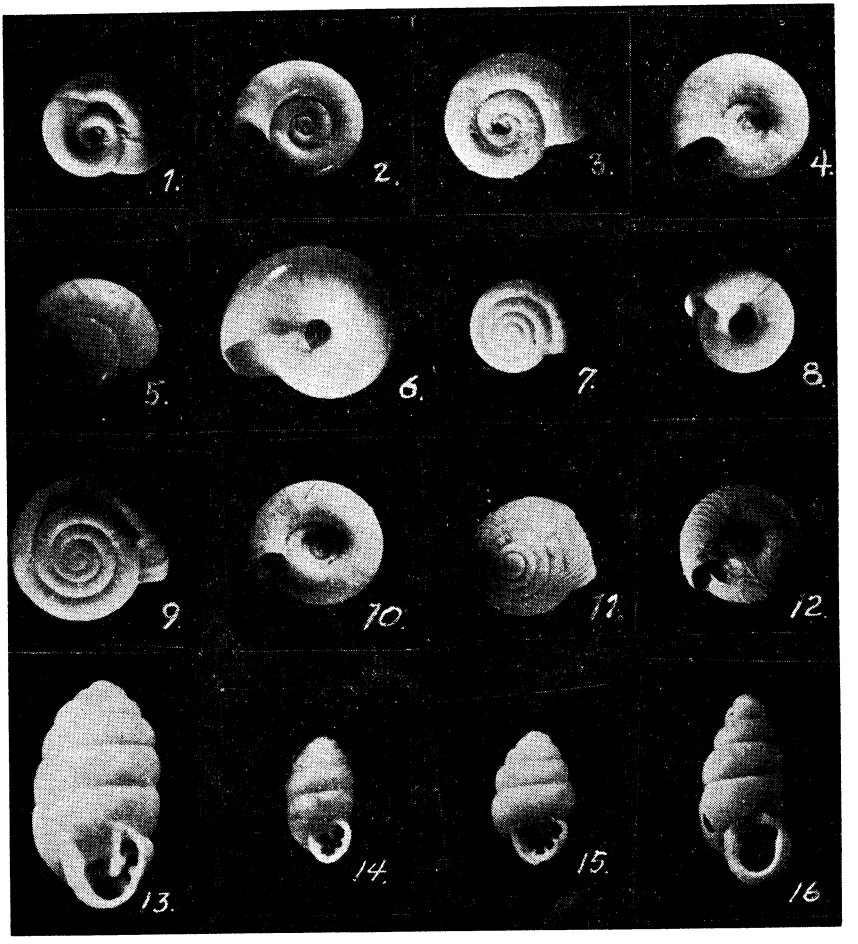

PLATE III. (Figures 1-12, X 4; 13-16, X 6)

1,2. *Gyraulus circumstriatus* (Tryon), p. 146
3,4. *Promenetus umbilicatellus* (Ckl.), p. 148
5,6. *Nesovitrea electrina* (Gould), p. 157
7,8. *Hawaiia minuscula* (Binney), p. 157
9,10. *Helicodiscus parallelus* (Say), p. 159
11,12. *Strobilops sparsicosta* Baker, p. 151
13. *Gastrocopta armifera* (Say), p. 152
14. *G. tappaniana* (Adams), p. 152
15. *Vertigo ovata* Say, p. 154
15. *Pupoides albilabris* (Adams), p. 154

Shell measurements:

Length	*Width*	*Aperture length*	*Aperture width*
2.2	1.1	0.9	0.6
2.1	1.1	0.8	0.6
2.1	1.1	0.7	0.7
2.3	1.4	1.0	0.8

Remarks.—Leonard and Goble (1952) concluded that *G. tappaniana* is a synonym of *G. pentodon*. Leonard (1959), however, gave validity to each of the two species and stated that the shells of tappaniana are "markedly more conic, usually larger, and the body whorl is noticeably larger than the rest of the whorls." Pilsbry (1948) wrote that intergradation occurred between these two species, but ecologically the two species are different. *G. tappaniana* inhabits moist areas, whereas *G. pentodon* is usually found in drier habitats. Pilsbry (1948) also pointed out that *G. pentodon* has a wider distributional range than any other North American *Gastrocopta*. Recent shells in our collection which were identified by Dr. Pilsbry as *G. tappaniana* conform to our fossil shells.

PUPOIDES ALBILABRIS (Adams)

Present distribution.—"Eastern North America from southern Canada to the Gulf of Mexico, west to the Dakotas, Colorado and Western Arizona; northern Mexico, Cuba, Haiti, Puerto Rico, Bermuda" (Leonard, 1959, p. 181).

Geologic range.—Early Pliocene (Laverne local fauna) to Recent.

Ecology.—This hardy species has been collected in abundance from many wooded areas throughout Texas. It is tolerant enough to be found in unshaded open fields, although it prefers to live under logs, stones, and debris in wooded areas. Its wide range in Texas is due undoubtedly to the ability that this species has of withstanding drought and high temperature.

Shell measurements:

Length	*Width*	*Aperture length*	*Aperture width*
5.0	2.3	1.8	1.6
4.6	2.0	1.7	1.7
4.8	2.1	1.8	1.6
5.1	2.3	1.8	1.8

VERTIGO OVATA (Say)

Present distribution.—"Labrador to the West Indies, west to Arizona,

Utah, Oregon, and Alaska" (Pilsbry, 1948). *V. ovata* is widely distributed over Texas where local habitat situations are favorable.

Geologic range.—Early Pliocene (Laverne local fauna) to Recent.

Ecology.—This species prefers a moist habitat, and can be found in Texas in shaded areas, under and in rotting logs, damp leaves, and other moist debris. It usually occurs near water or in areas where abundant moisture is always present.

Shell measurements:

Length	*Width*	*Aperture length*	*Aperture width*
1.8	1.3	0.7	0.8
2.3	1.3	0.7	0.8
2.2	1.3	0.7	0.8
2.0	1.2	0.6	0.8
1.9	1.3	0.6	0.8

Remarks.—It is interesting to note how even the fossil shells of this species retain a rich reddish-brown to tan color. In east Texas, where large colonies of this species have been found in humid habitats, the shell color is usually much darker than the color of shells of the same species in other parts of the state. This fast color must be due to a different type of chemical pigment than that which gives the color to certain other genera whose fresh shells are similar in color, yet are well bleached as fossils.

Family Succineidae

SUCCINEA sp.

Description.—Most of the *Succinea* of the Byers local fauna bear a closer shell description to *S. grosvenori* Lea than to other species of this genus. Specific identification, however, is not possible with the known diagnostic features of the shells.

Present distribution.—*S. grosvenori* has been reported from Ontario, Canada, south to Florida, Texas, and New Mexico; north to Montana and North Dakota.

Geologic range.—Since specific identification is not possible, the geologic range is not known.

Ecology.—In Dallas County, *S. grosvenori* has been collected in low, moist areas as well as under thin blankets of humus in relatively dry habitats.

Shell measurements:

Length	*Width*	*Aperture length*	*Aperture width*	*Spire*	*Whorls*
5.9	3.6	3.5	2.2	2.5	3.5
6.6	3.5	3.5	2.9	3.0	3.5
5.5	3.0	3.2	2.2	2.3	3
4.3	2.3	2.2	1.6	1.9	2.5
4.5	3.3	3.2	1.9	2.5	3

Remarks.—Since *Succinea* sp. more closely resembles in general description S. *grosvenori,* the general habitat has been given for this species. As has been pointed out by other workers on shell systematics, it is practically impossible to separate certain succineid species without the soft parts.

SUCCINEA OVALIS (Say)

Present distribution.—"Newfoundland and James Bay North Dakota and Nebraska south to Alabama" (Pilsbry, 1948). Leonard (1959) states that this species "barely enters northeastern Kansas."

Ecology.—Leonard (1959) states, "In Kansas, *Succinea ovalis* was generally found in shaded, damp situations along the base of bluffs, sometimes at considerable distances from the river. Invariably, the snails were on the ground under a protective cover of grass, leaves, and twigs." Oughton (1948) stated that in testing the ability of S. *ovalis* to withstand drought, one specimen remained alive without water 5 weeks and another 19 weeks.

Shell measurements:

Length	*Width*	*Aperture length*	*Aperture width*	*Spire*
18.0	10.6	12.4	8.2	7.3

Remarks.—Only two shells of this species have so far been found in the Byers deposit. One of these shells was so badly damaged in removal that it was impossible to make accurate measurements. It was, however, approximately of the same size as the one whose measurements are given.

OXYLOMA RETUSA (Lea)

Present distribution.—O. *retusa* has been reported from Ohio, Illinois, Iowa, Minnesota, North Dakota, and Montana (Pilsbry, 1948). It has been reported also from northeast Kansas (Leonard, 1959).

Geologic range.—Early Pleistocene (Dixon local fauna) to Recent.

Ecology.—"In northern Nebraska this species was always found within about 6 inches of permanent water, crawling about on dead wood or among riparian vegetation and debris" (Taylor, 1960).

Shell measurements:

Length	*Width*	*Aperture length*	*Aperture width*	*Spire*
15.3	7.4	10.3	6.3	6.5
14.9	6.2	9.5	5.2	5.7
12.5	4.3	8.2	4.2	5.5
11.4	5.5	8.0	5.0	4.9
8.5	4.2	5.7	3.4	3.8

Remarks.—To our knowledge this species has not been reported from Texas.

Family Zonitidae

NESOVITREA ELECTRINA (Gould)

Present distribution.—"From southeastern Canada south to Mexico in the Rocky Mountain States; not known in Texas except in archaic faunas; Kansas, Missouri, and Maryland in the east. Generally north of Lat. 38 N." (Pilsbry, 1946).

Geologic range.—Late Pliocene (Rexroad local fauna) to Recent.

Ecology.—"This snail has been found in both upland wooded areas and along the margins of streams. It seems to require a fairly moist environment, not occurring out in open grasslands as does *Zonitoides arboreus* with which *electrina* is elsewhere frequently associated. It is to be looked for under sticks, logs, rocks and in crevices of bark as well as in leaf litter" (Leonard, 1959).

Shell measurements:

Diameter	*Depth*	*Aperture length*	*Aperture width*
4.0	2.0	1.9	1.8
4.3	2.4	2.0	1.9
3.7	2.0	1.8	1.5
3.5	1.9	1.7	1.6

HAWAIIA MINUSCULA (Binney)

Present distribution.—"It is generally spread over every eastern and midwestern state, and in Florida as far south as Miami and Cape Sable, though not seen from the Keys. It becomes rather local from the Rocky Mountain States, and has not been seen from Washington, Oregon, Idaho, Nevada, and Utah, and only towards

the south in California, where some records are probably owing to importation with plants" (Pilsbry, 1946).

Geologic range.—Late Miocene (Barstow formation) to Recent.

Ecology.—*Hawaiia minuscula* is found under and in rotting logs, under rocks, humus, in compact mats of grass roots, all of which may occur from well-drained exposed hillsides, sparse woodlands, flooded areas and deep moist woodlands. The wide distributional range of this species is correlated with its adaptability to occupy habitats ranging from semi-arid to highly humid areas.

Shell measurements:

Diameter	*Depth*	*Aperture length*	*Aperture width*
2.2	1.3	0.8	0.7
2.4	1.3	0.8	0.7
2.1	1.1	0.8	0.7
2.2	1.3	0.8	0.7

EUCONULUS FULVUS (Muller)

Present distribution.—"Almost throughout the Holarctic realm, but wanting in the Gulf and south Atlantic States from Texas to North Carolina" (Pilsbry, 1946).

Geologic range.—Middle Pliocene to Recent; not known in North America earlier than Kansan (Cudahy fauna) age.

Ecology.—*E. fulvus* lives among stream borders in wooded areas or in other protected areas where moisture is plentiful.

Shell measurements:

Diameter	*Depth*
2.5	2.0
2.4	2.3
2.8	2.4

Remarks.—All recent specimens in our collection have been identified by Dr. Pilsbry as *E. chersinus trochulus*. Shell variations occur to such an extent, however, that one could easily mistake identification at this subspecies level.

Family Polygyridae

STENOTREMA LEAI LEAI (Binney)

Present distribution.—Eastern United States from New York to Maryland, south to Alabama, west from Texas to Kansas (Pilsbry, 1940).

Geologic range.—Kansan (Cudahy fauna) to Recent.

Ecology.—S. *leai* is found in central and western Texas in humid areas, near streams and rivers in protected wooded areas where it dwells under leaves, logs, and stones.

Shell measurements:

Diameter	*Depth*	*Aperture length*	*Aperture width*
11.0	5.6	3.0	5.9
9.9	5.5	2.1	5.0
9.7	5.5	2.3	5.2
10.4	6.2	3.7	6.2
8.9	5.0	2.7	5.2

Remarks.—Our fossil shells more closely resemble S. *leai leai* than S. *leai aliciae*. The wider aperture and open umbilicus are more apparent in our specimens. However, most of the recent *leai* in our collections from Texas were identified by Dr. Pilsbry as *aliciae*. We believe that further studies on this species will reveal considerable intergradation.

Family Endodontidae

HELICODISCUS PARALLELUS (Say)

Present distribution.—Eastern North America, from Newfoundland south to Alabama, and Georgia, westward to South Dakota, and Oklahoma (Pilsbry, 1948).

Geologic range.—Nebraskan to Aftonian (Dixon local fauna) to Recent.

Ecology.—*Helicodiscus parallelus* occurs in north central Texas in wooded areas. It is usually associated with most rotting wood but has been found under rocks where moisture is present.

Shell measurements:

Diameter	*Depth*	*Aperture length*	*Aperture width*
3.7	1.2	.06	1.2
2.6	1.0	.08	0.8
3.3	1.2	.08	1.0

Remarks.—This species occur in the Dallas area and is found most abundantly in woodland habitats subject to intermittent flooding. Shell measurements of recent shells in the Dallas area average at least one-fourth larger than the fossil shells from the Byers site.

DISCUSSION

The assumption of a lacustrine deposit is based not only upon the homogeneity in distribution of the fossil shells but the fact that many of these species are typically dwellers of swales, lakes and ponds. Also assuming that the ecological requirements of the species found in the Byers deposit have changed little since Illinoian times, the ancient oxbow lake described in the introduction would be a suitable habitat for the Byers molluscan fauna. The lake, which must have been isolated from the Red River and supplied by overflow water and drainage from the surrounding area, was probably so greatly reduced in size during dry periods that it became a semi-stagnant, shallow-water pond. Yet it retained enough water for the continued propagation and optimum growth of *Physa gyrina,* which was the dominant aquatic species. Although this species seems to thrive best in permanent water, it can survive periods of drought by burrowing in the mud (Mozley, 1932). Such specimens as do survive by this method are probably small because of their immaturity. In the Byers deposit unusually large *Physa gyrina* shells are very numerous. The presence of woodland species such as *Nesovitrea electrina* and *Stenotrema leai* indicate a wooded area in the lake region.

The climate of north central Texas today would not be favorable to most of the molluscan species found in the Byers deposit. Although some of the Byers species occur at present in north-central Texas, it must be noted that these species are the more tolerant widely-ranging ones presently distributed over a large portion of North America, both in the northern as well as the southern latitudes. Many Byers species could not withstand the present seasonable "highs" in temperature of the area today. All of these species, however, could tolerate much lower temperatures and for longer periods than those which exist today in north-central Texas.

Gyraulus circumstriatus, Planorbula armigera, Promenetus umbilicatellus, Physa gyrina, Succinea ovalis, Oxyloma retusa, Nesovitrea electrina, Pomatiopsis lapidaria, and *Lymnaea exilis* are all northern species. Since they were found in a southern latitude this would probably indicate a southerly drift during a glacial age, and would, therefore, place the Byers deposit in a glacial age.

In the Sagamon shell deposits of the T-2 Terrace at Dallas, a

mixture of southern and northern species of mollusca was found in common assemblage. Other deposits, thought to be of Sangamon age and now under study, also contain a mixture of species. The overlapping of northern and southern species would indicate a more stable climate, lacking both extreme seasonal "highs" and "lows" in temperature, which is not comparable to the climate of any large land area in the United States today. To our knowledge, no living faunas within the United States are comparable to recorded interglacial faunas.

The Byers molluscan fauna does not contain a single species which is restricted to a truly southern distributional-range. This clearly separates the Byers fauna from the Sangamon (last major interglacial) age. It is not likely that the Byers deposition could have taken place during the Yarmouthian inter-glacial stage, since it has been assumed that the Yarmouthian stage was semi-arid. Unfortunately, not enough Yarmouthian faunas are available for comparison at this time.

It can, thus, be concluded from the evidence at hand that the age of the Byers deposit was Illinoian. As more Texas local faunas become available for study, more precise dating can be assured. By the same token we can also more accurately describe the ecological conditions of the past by making more detailed habitat studies on recent molluscan species.

Table 1. Stratigraphic Occurrence of Mollusks in the Comparative Faunas.

	DIXON Nebraskan	SANDERS Aftonian	FRYE & LEONARD Kansan	PEARLETTE ASH Kansan	BYERS	BERENDS Illinoian	FRYE & LEONARD Illinoian	CRETE-LOVELAND Illinoian	BAR M Illinoian	T-2 TERRACE Sangamon	REZABEK Sangamon	JINGLEBOB Sangamon	JONES Wisconsin	PEORIAN Wisconsin
Valvata tricarinata	x			x		x					x	x	x	
Marstonia crybetes	x													
Carychium exiguum	x							x				x		x
Lymnaea caperata	x	x	x	x	x	x	x		x			x	x	
Lymnaea reflexa	x		x	x										
Fossaria dalli	x	x	x				x							
Bulimnea megasoma	x		x											
Anisus pattersoni	x			x										
Gyraulus parvus	x	x	x							x	x			
Helisoma anceps	x		x	x			x	x		x		x		
Helisoma trivolvis	x		x	x	x	x		x	x	x	x	x	x	
Planorbula armigera	x					x				x				
Promenetus kansasensis	x	x				x								
Promenetus umbilicatellus	x	x			x									
Acroloxus coloradensis	x													
Ferrissia meekiana	x													
Ferrissia rivularis											x			
Physa anatina	x	x	x	x			x	x			x		x	
Physa gyrina	x		x	x	x	x			x	x		x		
Physa skinneri	x	x				x	x		x					
Strobilops sparsicosta	x		x	x	x			x						

* More late Pleistocene faunas have been used for this comparison because most of the river terrace deposits of northern Texas have been proved to be more recent than Kansan age. The presence of the elephant bones which are probably those of a mammoth would also indicate a later age for the deposit.

Table 1, *Continued*

	DIXON Nebraskan	SANDERS Aftonian	FRYE & LEONARD Kansan	PEARLETTE ASH Kansan	BYERS	BERENDS Illinoian	FRYE & LEONARD Illinoian	CRETE-LOVELAND Illinoian	BAR M Illinoian	T-2 TERRACE Sangamon	REZABEK Sangamon	JINGLEBOB Sangamon	JONES Wisconsin	PEORIAN Wisconsin
Gastrocopta armifera	x		x	x	x	x	x		x			x	x	x
Gastrocopta chauliodonta	x	x												
Gastrocopta cristata	x	x	x	x			x	x	x			x		
Gastrocopta p. hordeacella	x													
Gastrocopta procera	x			x		x	x			x	x	x	x	
Gastrocopta scaevoscala	x													
Gastrocopta tappaniana	x	x	x	x	x	x	x	x	x	x		x		
Pupoides albilabris	x	x	x	x	x	x	x	x	x	x		x	x	x
Vertigo milium	x	x	x	x										x
Vertigo ovata	x	x	x	x	x	x	x	x	x					
Vallonia perspectiva	x	x												
Oxyloma retusa	x				x	x			x			x		
cf. Succinea	x	x	x	x	x	x	x	x	x	x			x	x
Helicodiscus parallelus	x		x	x	x	x	x	x	x	x	x	x		x
Helicodiscus singleyanus	x	x	x				x		x					x
Deroceras aenigma	x	x		x										
Nesovitrea electrina	x		x	x	x		x	x	x	x		x		x
Hawaiia minuscula	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Zonitoides arboreus	x		x	x				x	x			x		x
Lymnaea b. techella		x												
Lymnaea bulimoides			x	x					x				x	
Aplexa hypnorum		x	x	x		x			x			x	x	
Gastrocopta paracristata		x												

Table 1, *Continued*

	DIXON Nebraskan	SANDERS Aftonian	FRYE & LEONARD Kansan	PEARLETTE ASH Kansan	BYERS	BERENDS Illinoian	FRYE & LEONARD Illinoian	CRETE-LOVELAND Illinoian	BAR M Illinoian	T-2 TERRACE Sangamon	REZABEK Sangamon	JINGLEBOB Sangamon	JONES Wisconsin	PEORIAN Wisconsin
Pupilla muscorum			x	x			x	x	x				x	x
Pupilla blandi			x	x			x	x	x				x	x
Discus cronkhitei			x	x			x	x	x					x
Lymnaea palustris			x	x					x		x	x	x	
Fossaria parva			x				x		x				x	
Euconulus fulvus			x		x				x			x		
Gyraulus similaris			x	x			x							
Vallonia gracilicosta			x	x			x	x				x	x	x
Vallonia pulchella			x	x							x			
Vallonia parvula			x				x					x		
Gastrocopta proarmifera			x	x										
Gastrocopta riograndensis			x				x							
Polygyra texasiana			x	x						x				
Stenotrema leai			x	x	x	x			x	x		x		
Strobilops texasiana			x							x		x		
Carychium perexiguum				x			x	x						x
Retinella indentata			x											x
Planorbula armigera				x	x						x			
Ferrissia parallela				x					x		x	x		
Pomatiopsis cincinnatiensis				x										
Gastrocopta holzingeri				x			x	x				x		x
Amnicola l. parva				x							x			
Vertigo modesta				x			x							x

Table 1, *Continued*

	DIXON Nebraskan	SANDERS Aftonian	FRYE & LEONARD Kansan	PEARLETTE ASH Kansan	BYERS	BERENDS Illinoian	FRYE & LEONARD Illinoian	CRETE-LOVELAND Illinoian	BAR M Illinoian	T-2 TERRACE Sangamon	REZABEK Sangamon	JINGLEBOB Sangamon	JONES Wisconsin	PEORIAN Wisconsin
Vertigo tridenta				x				x						
Cionella lubrica				x					x					x
Gastrocopta contracta				x					x		x	x		
Discus shimeki				x			x							x
Fossaria obrussa						x			x			x		
Lymnaea exilis					x	x								
Gyraulus circumstriatus					x	x			x		x	x		
Armiger crista						x			x					
Deroceras laeve						x		x						x
Strobilops labyrinthica								x						
Lymnaea stagnalis									x				x	
Oxyloma haydeni							x		x			x		
Pupoides inornatus									x				x	
Gastrocopta pentodon										x				
Bulimulus dealbatus										x				
Helicina o. tropica										x				
Mesodon thyroidus										x				
Pupisoma dioscoricola										x				
Lymnaea h. modicella						x					x			
Strobilops affinis											x			
Promenetus exacuous												x	x	
Pomatiopsis lapidaria					x									
Succinea ovalis				x	x			x						x

Table 2. Vertical Range Chart*

Byers Local Fauna	*Vertical ranges transferred from Table 1*							
	Nebraskan	Afonian	Kansan	Yarmouthian	Illinoian	Sangamon	Wisconsin	(North Texas) Recent
Helisoma trivolvis	x		x		x	x	x	x
Promenetus umbilicatellus	x	x						
Physa gyrina	x		x		x	x		
Strobilops sparsicosta	x		x		x			
Gastrocopta armifera	x		x		x	x	x	x
G. tappaniana	x		x		x	x		x
Pupoides albilibris	x		x		x	x	x	x
Vertigo ovata	x	x	x		x			x
Oxyloma retusa	x				x	x		
cf. Succinea	x	x	x		x	x	x	x
Helicodiscus parallelus	x	x	x		x	x	x	x
Nesovitrea electrina	x		x		x	x	x	
Hawaiia minuscula	x	x	x		x	x	x	x
Euconulus fulvus			x		x	x		x
Stenotrema leai			x		x	x		x
Planorbula armigera	x		x			x		
Lymnaea exilis					x			
Lymnaea caperata	x	x	x		x	x	x	
Gyraulus circumstriatus					x	x		
Succinea ovalis			x		x		x	
Pomatiopsis lapidaria								

Not perfectly known, due to insufficient comparative faunas

* See explanation in text.

Table 3. Habitat Indications of Byers Fauna.

	Abundance of shells based upon numbers of each species found in total matrix examined A=over 100; C=25-100; S=10-25; R=1-10	Temporary water species	Permanent water species	Woodland species	Species restricted to northern distribution	Species restricted to southern distribution	Species widely distributed north and south	
Helisoma trivolvis	C	X					X	Often found associated with Helisoma anceps in permanent water
Planorbula armigera	A	X			X			
Gyraulus circumstriatus	S	X			X			Found associated with Gyraulus parvus in permanent water
Promenetus umbilicatellus	R							
Physa gyrina	A	X			X			
Lymnaea exilis	S	X			X			
Lymnaea caperata	C	X					X	
Pomatiopsis lapidaria	C	X			X			
Gastrocopta armifera	C			X			X	
Gastrocopta tappaniana	C			X			X	
Pupoides albilabris	C			X			X	
Vertigo ovata	A			X			X	
Strobilops sparsicosta	R			X				Extinct species; range unknown
Euconulus fulvus	R			X			X	
Succinea ?	S							Specific identification cannot be made from shells
Succinea ovalis	R			X	X			
Oxyloma retusa	C			X	X			
Helicodiscus parallelus	R			X			X	
Nesovitrea electrina	S			X	X			
Hawaiia minuscula	A			X			X	
Stenotrema leai	C			X			X	

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