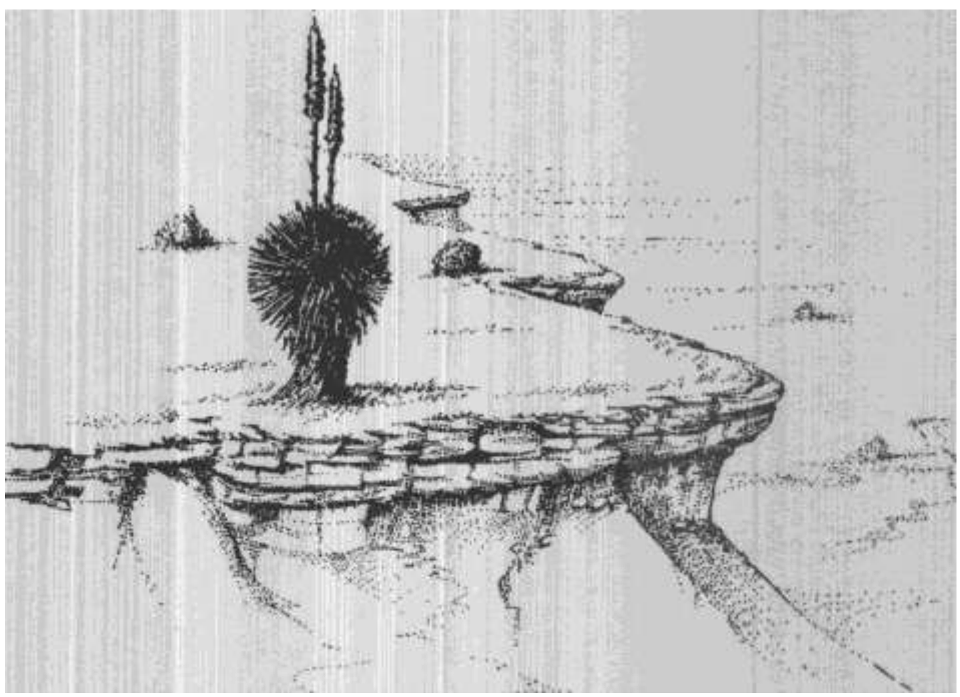
CIRCULAR 145

Late Cenozoic Mollusks and Sediments, Southeastern New Mexico

by A. Byron Leonard, John C. Frye, and H. D. Glass



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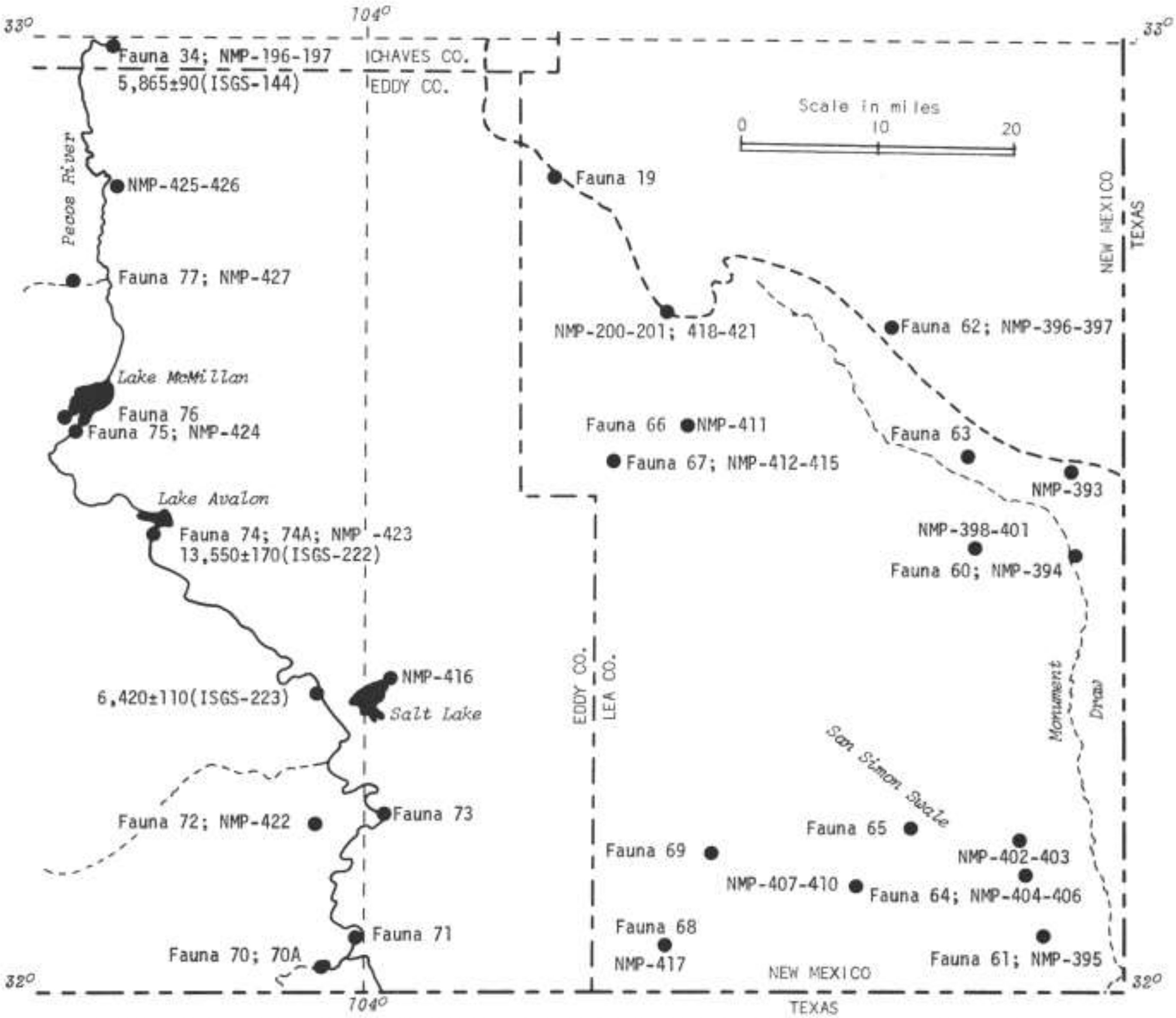

FIGURE 1—Map of southeastern New Mexico showing locations of molluscan faunas described, lithologic samples (NMP-) from which clay minerals were analyzed, and of radiocarbon dates determined on mollusk shells. Heavy dashed line in the northern quadrant shows the generalized position of the Ogallala-capped escarpment at the southwestern limit of the upland plateau of the High Plains.

Abstract

Collections of late Pleistocene fossil shells from 20 localities yielded a total of 30 species of mollusks. The faunas in the southeastern area are less abundant and somewhat less varied than the faunas farther north in New Mexico. South of the bounding escarpment of the Ogallala-capped High Plains, mineral composition and lithology of three Ogallala outliers show consistency with the Ogallala clay-mineral zones described farther north. The Wisconsinan pond and lake deposits south of the High Plains contain sepiolite, and at one locality both sepiolite and attapulgite, in contrast to the terrace deposits of the Pecos valley. However, the molluscan faunas of the two areas do not differ significantly.

Introduction

The late Cenozoic deposits of extreme southeastern New Mexico have received little attention until recently (Vine, 1963; Reeves, 1972; Bachman, 1973). Following several of our most recent studies in east-central New Mexico (Frye and Leonard, 1972; Glass and others, 1973; Leonard and Frye, 1975; Frye and others, 1974), we conducted a reconnaissance of the late Cenozoic geology of the southeastern part of the state to determine whether the conclusions reached in the northern work were applicable to the south. Correlating data from southeastern New Mexico with stratigraphic and paleontologic data from adjacent Texas (Leonard and Frye, 1962; Frye and Leonard, 1957; 1968), and with clay-mineral data from the southern High Plains of adjacent Texas (Parry and Reeves, 1968) were also considered.

The area studied includes the dissected lowland in Lea County south of the escarpment marking the boundary of the Ogallala-capped upland plateau within the High Plains, and in Eddy County, the largely pedimented surfaces extending west to the Pecos valley. The topography of this part of the region is the result of Pleistocene erosion and deposition, and is characterized by outliers of Ogallala Formation, buttes and mesas of Triassic and Permian rocks, pediments, colluviated surfaces, and collapse basins of various sizes as a result of solution of the underlying Permian rocks.

The Pleistocene history of Pecos valley has been described (Leonard and Frye, 1975). In eastern New Mexico, the Pecos River in its present course is post-Kansan in age. The early Pleistocene terraces north of Chaves County are related to eastward drainage through the now abandoned Portales valley, and only the Wisconsinan terraces of Pecos valley are related to drainage from the upper part of the basin.

The field work for the present investigation was carried out by Frye and Leonard during a few days in the summers of 1971 and 1972, and one week during the summer of 1973. This southeastern reconnaissance should be considered an extension of earlier work farther north in east-central New Mexico (Frye and Leonard , 1972; Glass and others, 1973; Leonard and Frye, 1975; Frye and others, 1974). C. C. Reeves, Jr. and John W. Hawley critically reviewed the paper.

CLIMATE AND VEGETATION

The climate of southeastern New Mexico may be characterized as arid; rainfall averages about 10 inches annually. The continental interior location on a plain lacking barriers to air flow produces abrupt changes in temperature, rainfall, and wind direction. Average annual evaporation is about 100 inches, approximately ten times the average annual rainfall. High evaporative rates are encouraged by high summer temperatures, preponderance of sunny days, and strong air movements. Sunshine averages about 75 percent of the total possible sunshine, from about 66 percent to as high as 90 percent. Monthly wind movement over the evaporating pans (Bitter Lakes and Lake Avalon Stations) ranges from about 1600 miles in December to well over 3000 miles in March and April. In 1971, Bitter Lakes Station reported total evaporation of 91.1 inches for 11 months of record, while in the same period Lake Avalon Station reported 114.4 inches (Climatological Data, 1971, 1972). The erratic distribution of rainfall is exemplified by that in the month of September, 1972 when Maljamar Station reported 5.65 inches while Jal Station recorded only 0.74 inches. Most of the precipitation occurs in the period from May to October; winters are very dry with some stations recording no rainfall for several months. Snowfalls rarely leave more than 2 inches of accumulation. Temperatures vary widely ranging from below 0°F. in January and February to more than 100°F. in July and August.

The result of these climatic characteristics is a countryside with sparse vegetative cover. No permanent streams occur in Lea County; the only permanent stream in Eddy County is the Pecos River. Native vegetation consists predominantly of short and medium grasses and forbs. Few native trees exist, but the cottonwood *(Populus sargentii)* and willows *(Salix* sp.) occur along watercourses, especially the Pecos River. Some exotic trees have successfully colonized certain environments *(Tamarix* sp., of Mediterranean origin, occurs locally in dense thickets on flood plains of the Pecos River). Shrubs are found primarily along the Pecos River and along some dry watercourses.

Mesquite, a small tree or shrub, *Prosophis glandulosa,* colonizes sandy areas such as the Mescalero Plain below the escarpment of the Ogallala Formation. This hardy shrub often sends its taproot 60 ft into the earth in search of water to support a plant a few feet high. *Juniperus monospermum* is a tree that behaves as a shrub in dry upland areas, especially along the escarpment and steep slopes of the Ogallala Formation. Farther north *J. monospermum* is often associated with the piñon pine, *Pinus edulis.* Various cacti, especially species of *Opuntia* and *Mammallaria* form outstanding features of the upland flora in southeastern New Mexico. Another characteristic element of the flora is soapweed or beargrass, *Yucca glauca.* The dead leaves that cling to the base of this plant trap moisture and provide a haven for some gastropods, such as species of the genus *Succinea.* Spiny cacti, especially *Opuntia,* discourage grazing close to the base of a plant cluster, thereby providing cover for mollusks.

The dry climate, generally sparse native vegetation, and widespread lack of permanent fresh surface water (saline lakes, such as Laguna Gatuña do not support molluscan life) produce a very poor environment for mollusks. The living molluscan fauna of southeastern New Mexico has not been studied, but observations indicate that it is extremely depauperate, even more so than the late Pleistocene faunas reported here (table 1).

TABLE 1—DEPOSITIONAL ENVIRONMENTS OF MOLLUSKS COLLECTED IN SOUTHEASTERN NEW MEXICO

Alphabetical list of molluscan species collected in southeastern New Mexico. (Localities 19, 34, previously reported, Leonard and Frye, 1974)	Depositional Environment																					
	Lacustrine	Lacustrine	Lacustrine	Lacustrine	Lacustrine	Lacustrine	Lacustrine	Lacustrine	Lacustrine	Lacustrine	Terrace	Terrace	Terrace	Lacustrine	Terrace	Terrace	Terrace	Terrace	Terrace	Terrace	?Lacustr.	Terrace
MOLLUSCAN SPECIES / LOCALITIES	60	61	62	63	64	65	66	67	68	69	70	70A	71	72	73	74	74A	75	76	77	19	34
Actinonais carinata (Barnes)**																						•
Armiger exigua Leonard*			•																			
Ferrissia rivularis (Say)*																						•
Gastrocopta armifera (Say)+																		•				•
Gastrocopta contracta (Say)+			•												•			•		•		
Gastrocopta cristata (Pilsbry & Vanatta)+					•			•									•				•	•
Gastrocopta pellucida hordeacella (Pilsbry)+																	•					
Gastrocopta pentodon (Say)+					•			•														
Gastrocopta tridentata (Leonard)+	•																					
Gyraulus circumstriatus (Tryon)*					•										•	•				•		
Gyraulus parvus (Say)*		•	•					•	•				•					•	•			•
Hawaiia minuscula (Binney)+					•						•		•		•	•	•	•		•		
Helisoma antrosa (Conrad)*																•			•			
Helicodiscus singleyanus (Pilsbry)+										•	•											
Lymnaea palustris (Müller)*		•	•																			
Lymnaea rustica (Lea)*			•		•			•														
Physa gyrina Say*			•		•									•					•	•		•
Physa anatina Lea*											•	•	•		•							
Pisidium compressum Prime**								•											•			
Polygyra texasiana (Moricand)+																		•				
Pupilla blandi Morse+	•							•	•												•	
Pupilla muscorum (Linné)+					•															•		
Pupoides albilabris (C.B. Adams)+								•	•						•	•		•				•
Sphaerium transversum (Say)**															•							
Somatogyrus subglobosus (Say)**																•						
Succinea gelida Baker+	•	•				•		•			•		•		•						•	
Succinea grosvenori Lea+	•	•	•	•	•	•	•	•	•	•	•				•	•	•		•	•	•	
Succinea luteola Gould+		•									•				•			•				•
Vallonia cyclophorella Sterki+					•			•												•		
Vallonia gracilicosta Reinhardt+	•						•	•													•	
TOTAL NUMBER OF SPECIES	5	5	7	1	9	2	2	11	4	2	6	1	4	1	9	6	4	7	5	7	5	8

* Pulmonate aquatic mollusk
** Branchiate aquatic mollusk
\+ Pulmonate terrestial mollusk

Ogallala Formation

In this region, the High Plains surface terminates as a distinct topographic break northeast of Monument Draw in Lea County (fig. 1). North of this escarpment (to central Roosevelt County), the High Plains surface is continuously underlain by Ogallala deposits. Traced to the northwest the topographic break becomes more prominent; near the southeastern corner of Chaves County the trend becomes more northerly and is recognized as the southern part of the Mescalero Escarpment. Along this escarpment, the Buckeye SW Section (N MP-200, 201; 418-421; table 2) has been described (Frye and others, 1974). The Ogallala Formation deposits here are typical of the formation farther north where 5 clay-mineral zones have been recognized in stratigraphic sequence. The Buckeye SW Section contains a clay-mineral assemblage found in Ogallala clay-mineral Zones 2 and 3; the section is capped by the pisolitic limestone (Zone 5). Opal occurs abundantly in Ogallala clay-mineral Zones 2 and 3. The deposits of the Ogallala Formation along the escarpment of the High Plains to the north and northwest are described elsewhere (Frye and Leonard, 1972; Leonard and Frye, 1975; Frye and others, 1974).

The deposits south and southwest of the topographic break at the margin of the upland plateau have been subject to differing interpretations by previous investigators (Lovelace, 1972; Bachman, 1973). In our reconnaissance of the region, three localities have the topographic setting, lithology, and clay-mineral composition to class them as outliers of the Ogallala.

Twelve miles west of Jal, on a flat upland surface mapped as Quaternary (Lovelace, 1972, map 120; Bachman, 1973), exposures were studied in an excavation at an abandoned drilling site (fig. 2a) where 14 ft of beds are exposed (NMP-407-410; table 2). Below a few inches of loose, calcareous, eolian sand, occurs 1 to 11/2 ft of red-brown, leached sand and clay that appears to be the B-horizon of a soil. This B-horizon rests on a deeply solution-pitted caliche that serves as the parent material (undoubtedly augmented by sand from an early eolian cycle) of the buried near-surface soil. The clay-mineral composition of the beds below the surface of the pitted caliche clearly indicates correlation with the Ogallala Formation to the north. All 4 samples contain attapulgite, and the 2 upper samples contain a small amount of sepiolite, clearly placing the section in clay-mineral Zones 2 and 3 of the Ogallala (Frye and others, 1974). The upper 5 ft contains opal, also typical of Zones 2 and 3 of the Ogallala. This upland outlier has been subjected to erosion and soil formation during at least the post-Kansan part of Pleistocene time; as a result, the thin clay-mineral Zones 4 and 5 that mark the top 4 to 6 ft of the formation are not present. This upland outlier is flanked by graded slopes veneered with blocks of caliche, and other deposits, and mantled with a variable thickness of eolian sand. The mineral composition, topographic setting, and lithology leave no doubt that this upland area is an outlier of Ogallala Formation, even though geographically isolated south of the San Simon Swale. The thickness of the formation was not determined, but the presence of Triassic exposures on the lower slopes suggests that the Ogallala ranges between 20 and 50 ft thick in this area.

Another outlier of Ogallala (mapped as such by Lovelace in 1972 and Bachman in 1973), separated only by the broad valley of Monument Draw from the Ogallala escarpment to the north, is represented by samples NMP-398 to 401 (table 2). Here, in a State caliche pit on Eunice Mesa, a 10-ft section is exposed. The Ogallala is capped by pisolitic limestone and displays a clay-mineral composition typical of Zone 5. The clay-mineral assemblages (table 2) include abundant attapulgite and sepiolite at depths of 3 and 6 ft below the top, indicating that at least Ogallala clay-mineral Zones 5, 3, and 1 or 2 are exposed. The area is at the local upland level and not greatly below a projected slope of the High Plains surface south of Lovington. Although opal was not detected (and gypsum is present) all other parameters indicate that the deposit is an outlier of the Ogallala Formation.

The third outlier of Ogallala occurs slightly more than 3 miles north of Jal, where a caliche pit at the crest of a south-facing slope, exposes 8 ft of deposits. The clay-mineral composition of 2 samples (NMP-402 and 403; table 2) indicates Ogallala clay-mineral Zones 1 through 3 by the presence of abundant sepiolite and attapulgite accompanied by opal 3 ft below the surface. The pisolitic limestone, Zone 5, and clay-mineral Zone 4 are not present. A gently sloping surface bevels the exposure; apparently the surface is veneered with thin Pleistocene (Kansan) deposits that truncate the Ogallala outlier.

A common characteristic of these Ogallala outliers in the southeastern area of New Mexico is the general absence of typical pisolitic limestone at the top, as pointed out by Bachman (1973). At one locality (State caliche pit) pisolitic limestone (Zone 5) was observed, but commonly the upper part of the formation has been removed by erosion or solution pitting; the formation is relatively thin and discontinuous. In Pliocene time the Ogallala Formation probably covered much of the Lea County part of the area; evidence is lacking for its former presence in southern Eddy County.

(Table 2 & Figure 2 follow)

TABLE 2—CLAY MINERALS OF LATE CENOZOIC DEPOSITS IN LEA AND EDDY COUNTIES, NEW MEXICO (*values for illite in parentheses are estimated*)

Sample No. (NMP-)	Lithology	Distance below top of section (ft)	Clay mineral percent: Montmor-illonite	Illite	Kaolinite and chlorite	Attapul-gite	Sepio-lite	Remarks	Ogallala clay-mineral zone, or fauna locality ( )
					LEA COUNTY				
Ogallala Formation									
421	pisolitic ls.	0.3	20	58	22				5
420	platy caliche	3	14	(5)	2	79			3?
419	cem. sand	6	15	(5)	2	42	36		3
201	sand	15	10	(5)		85		opal	2
418	sand	25	15	(5)		80			2
200	sand	35	23	(5)		72		opal	2
398	pisolitic ls.	0.3	38	51	11				5
399	cem. sand	3	2	(5)		25	68	gypsum	3
400	red sand	6	23	(5)	3	53	16	gypsum	3
401	red sand	9	70	25	5	tr			1-2
402	platy caliche	3	4	(5)		46	45	opal	3
403	red sand	7	66	27	7	tr	tr		1-2
410	platy caliche	3	3	(5)		81	11		3
409	cem. sand	5	2	(5)		81	12	opal	3
408	sand	8	51	(5)	10	34			2
407	sand	11	40	(5)	6	49			2
Kansan deposits									
393	red soil				calculation impractical				
Wisconsinan deposits									
397	white silt	5	65	28	7				(62)
396	silt & sand	8			calculation impractical				(62)
394	grey silt	1	33	31	6		30		(60)
395	grey silt	4	16	37	10		37		(61)
406	blocky cal.	0.3	25	14	3		58		
405	sand & silt	1	21	14	3		62		(64)
404	sand & silt	4	12	24	5		59		(64)
411	sand & silt	1	6	20	3		71		(66)
417	sand & silt	1	26	29	6		39		(68)
415	grey sand	3	5	(5)	3	30	57		
414	grey sand	8	30	(5)	4	61			(67)
413	silt & clay	10	65	30	5			chlorite	
412	red clay	11	66	28	6			chlorite	
					EDDY COUNTY				
Pecos River Valley									
197	sand & silt	5			corrensite				(34)
196	sand & silt	6.5			corrensite			gypsum	
425	Permian sh.	5			corrensite				
426	Permian sh.	10			corrensite			gypsum	
427	silt & sand	3	54	37	9			chlorite	(77)
424	silt & sand	10	44	46	10			chlorite	(75)
423	sand & silt	3	49	41	10				(74A)
416	gyp. sand	2			gypsum				
422	gyp. silt	2			gypsum				(72)

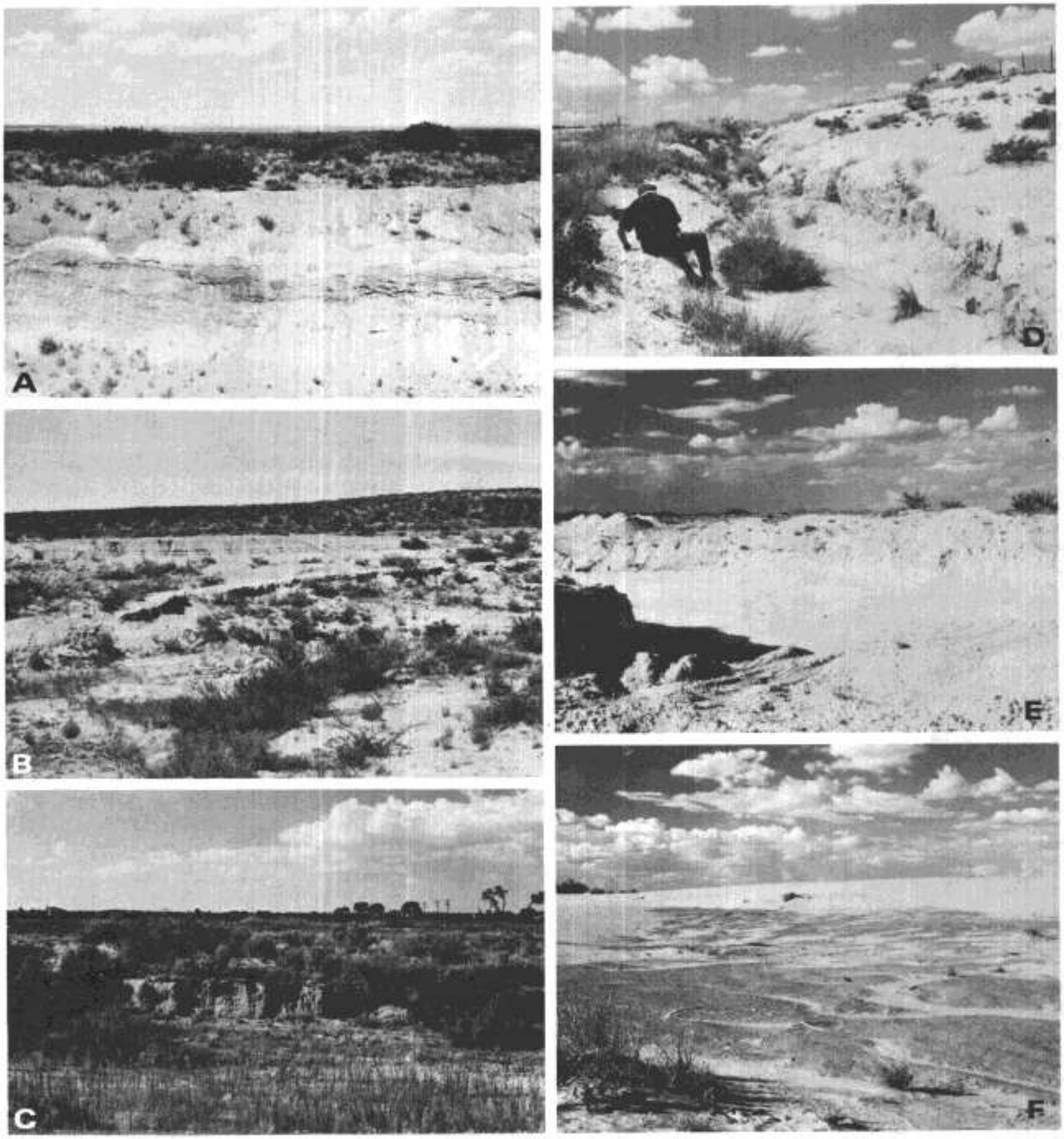

FIGURE 2—LATE CENOZOIC DEPOSITS IN LEA AND EDDY COUNTIES, NEW MEXICO.

A) Caliche pit in Ogallala Formation, overlain by weathered sand, 12 miles west of Jal, Lea County; NMP-407 to 410. (SE¼ sec. 19, T. 25 S., R. 35 E.)

B) Pleistocene deposits downstream from west end of Lake Avalon Dam, Eddy County. Fauna Locality No. 74 and No. 74A; NMP-423; radiocarbon date 13,550 170 (ISGS-222). (SE¼SE¼ sec. 11, T. 21 S., R. 26 E.)

C) Channel of Rio Peñasco across Woodfordian terrace of Pecos River, 7 miles south and 2 miles east of Artesia, Eddy County; Fauna Locality No. 77; NMP-427. (SW¼SE¼ sec. 15, T. 18 S., R. 26 E.)

D) Pleistocene exposures SE of Laguna Gatuña, Lea County, Fauna Locality No. 67; NMP-412 to 415. (NW¼NE¼ sec. 13, T. 20 S., R. 33 E.)

E) Pit in Late Pleistocene pond deposit, 4.5 miles north of Texas state line along NM-18, Lea County; Fauna Locality No. 61; NMP-395. (NE¼SE¼ sec. 9, T. 26 S., R. 37 E.)

F) Young eolian sand migrating over stabilized sand of an earlier cycle, 2.6 miles north of Texas state line, east of NM-18, Lea County. (SE¼SW¼ sec. 15, T. 26 S., R. 37 E.)

Pleistocene Deposits

In the area of this report, deposits of Pleistocene age occur as fills in basins of various sizes, shapes, and ages; as alluvial deposits of Kansan and younger ages; as colluvium and pediment veneers of Kansan and younger ages;_ and as veneers of eolian sand. Fossil mollusks and samples for clay-mineral analysis were collected from terrace deposits of Wisconsinan and Holocene age along the Pecos valley in Eddy County, and from Wisconsinan basin deposits of several types in southern Lea County.

PECOS VALLEY IN EDDY COUNTY

In extreme southern Chaves County, corrensite has been reported in terrace deposits, dated 5,865 ± 90 (ISGS-144) B.P., and from young sediments in collapse basins at Bottomless Lakes State Park (Glass and others, 1973). Two samples (NMP-425 and 426) of Permian shale below Kansan terrace gravels, east of Pecos River in Eddy County and less than 15 miles south of the Holocene terrace samples previously described, also yielded corrensite in association with gypsum (table 2). This area of New Mexico has an unusually large number of corrensite localities; the mineral was described from Permian rocks at the U.S. Potash Co. mine in Eddy County (Grim, Droste, and Bradley, 1960).

Although not sampled, Kansan deposits were observed at a few places in Pecos valley (the dissected terrace gravels east of Artesia and the caliche capped upland in the vicinity of Fauna 73 in southern Eddy County). These Kansan terrace deposits of reddish-tan sand and silt, with some gravel, capped by a prominent layer of caliche, and the extensive pediments west of the Pecos River, are considered equivalent to the extensive Surface No. II described by Leonard and Frye (1962) southeastward along the Pecos valley in Texas, and assigned an age of early to middle Pleistocene. The terrace portion of their Surface II is only that part immediately adjacent to the Pecos, and on the southwest side of the river in Reeves and Pecos Counties, Texas, an extensive pediment graded to the level of the terrace rises to the southwest. This pediment surface is below the level of the late Tertiary Surface I, and has been dissected in areas now occupied by Wisconsinan and younger pediments, Surfaces III and IV. This pediment relationship is present in Texas only on the southwest side of Pecos valley, as is also true in Chaves and Eddy Counties, New Mexico. Excellent and extensive Kansan pedimented surfaces occur in the vicinity of Roswell and Artesia, but are rare to lacking on the east side of the valley, in spite of the local occurrence of prominent Kansan terrace deposits adjacent to Pecos River (east of Hagerman, and of Artesia). In Eddy County, we did not identify an equivalent to Surface No. I, the Tertiary surface in Pecos and Reeves Counties, Texas. In that part of Texas this uppermost pediment, graded to the level of the Ogallala Formation, rises nearly 1,500 ft (Frye, 1969) south-southwest and away from the Pecos River channel as a smoothly graded pediment surface. The Ogallala outliers in southern Lea County may be related to this surface.

The gradient of the Kansan level along the Pecos River in Eddy County, New Mexico, and downstream nearly to McCamey, Texas, gradually converges with the gradient of the present flood plain. In the region of resistant Cretaceous limestones below McCamey, the gradient of Pecos River sharply and strongly increases, and terrace levels strongly diverge from the Pecos River gradient (Leonard and Frye, 1962). The relatively small vertical interval separating the Kansan stream gradient from the Holocene Pecos River gradient in extreme southern New Mexico, and adjacent Texas, contrasts with the much greater vertical separation of these two levels in De Baca and Guadalupe Counties, New Mexico, where the former drainage of the present Pecos valley flowed eastward through the now abandoned Portales valley until after Kansan time. In the area of the early Pleistocene drainage divide in northern Chaves and southern De Baca Counties, we did not find terrace levels in Pecos valley above the Wisconsinan terrace surfaces.

WISCONSINAN TERRACE DEPOSITS

The Woodfordian terrace deposits of the Pecos valley in Eddy County (NMP-423, 424, 427) contain a clay-mineral assemblage similar to that in the terraces of the same age to the north in Chaves, De Baca, and Guadalupe Counties (Glass and others, 1973). The young age of the terrace deposits is indicated by radiocarbon dates of 13,550 ± 170 (ISGS-222) B.P. (fig. 2b) at the locality of NMP-423, and 6,420 110 (ISGS-223) B.P. from a terrace about 20 miles downstream.

A sample of particular significance was taken from the channel bank of the Rio Peñasco, where the Rio Peñasco approaches the Pecos River and crosses the Woodfordian terrace (fig. 2c; NMP-427; fauna 77). The clay-mineral composition of the sediments (more than half montmorillonite, moderate illite, and kaolinite plus chlorite) is similar to that of the Pecos valley Wisconsinan terraces upstream, but the channel gravels are predominantly well rounded limestone pebbles from the west.

Two samples in southern Eddy County are predominantly gypsum; clay minerals were not recovered for X-ray analysis. One sample is from the deposits of Salt Lake (NMP-416); the other (NMP-422) from a small fossiliferous (fauna 72) pond deposit.

PLEISTOCENE DEPOSITS IN SOUTHERN LEA COUNTY

The Pleistocene deposits of southern Lea County may be classed in four general categories: 1) Extensive pediment veneers and remnants of deposits on intermediate surfaces, of probable Kansan age; 2) basin deposits with detrital minerals assemblages but lacking attapulgite and sepiolite; 3) basin deposits containing significant amounts of sepiolite and/or attapulgite; and 4) the widespread surface veneers of eolian sand.

Deposits of probable Kansan age were sampled at only one locality (NMP-393). Here, on an intermediate level below the Ogallala surface to the north, 20 ft of section is exposed in a borrow pit. At the top of the section is 2 to 3 ft of loose, tan, eolian sand, overlying 7 ft of red-brown clay and sand, gradational at the base into reddish-tan to pinkish-tan, relatively loose sand. The sample is from 1 ft below the top of the red-brown B-horizon material. Weathering has been so intense that clay-mineral composition is not calculable from X-ray analysis. This is typical of the B-horizon developed on Kansan deposits described from De Baca County (Glass and others, 1973). The degree of weathering greatly exceeds the maximum observed on Wisconsinan deposits throughout the region.

Although not sampled, deposits of probable Kansan age occur at many places in southern Lea County. Pediment veneers occur discontinuously, but extensively, south of the boundary escarpment of the High Plains. Discontinuous veneered pediment segments and colluvial deposits occur at many places throughout the area.

One deposit was sampled from a basin in the Ogallala Formation, and just below the High Plains surface. This deposit did not contain sepiolite (NMP-397; fauna 62) but displayed a detrital clay-mineral assemblage of 65 percent montmorillonite, 28 percent illite, and 7 percent kaolinite. Ten ft of basin deposits were exposed; light-gray silt, fine sand, and caliche in the upper part, and yellowish-gray sand and silt with some $CaCO_3$ in the lower part. The clay-mineral assemblage in the lower part (NMP-396) indicates a considerable degree of weathering, suggesting the sediment was derived by sheet wash from the adjacent weathered Ogallala. The clay-mineral assemblages are similar to those reported for a basin fill northwest of Elida, Roosevelt County (N MP-221; Glass and others, 1973).

Six basin deposits sampled in southern Lea County contain sepiolite ranging from 30 percent to 71 percent of the clay minerals (table 2). All these fossiliferous localities (faunas 60, 61, 64, 66, 67, 68) are south of the bounding escarpment of the High Plains, well below the elevation of the upland level of the outliers of Ogallala Formation in the region. In general, the deposits are gray, calcareous silt, with some fine to medium sand. The basin fills range from small deposits (NMP-394 and 411) to lake basins one or more miles across (NMP-404 to 406), and more than 10 ft thick (NMP-395; fig. 2e). Although none of the faunas in southern Lea County have been carbon dated, the similarity of topographic setting, lithology, clay-mineral assemblage, and dated molluscan faunas farther north (Glass and others, 1973; Leonard and Frye, 1974) indicates they are Wisconsinan, probably Woodfordian.

A basin deposit with an unusual clay-mineral assemblage is exposed in road excavations (fig. 2d) on the southwest side of Laguna Gatuña (fauna 67). Twelve ft of deposits are exposed in the rim of a present playa; the character of the sediments indicates a nearshore position at a higher lake level. At the base (NMP-412) is red clay, silt, and some sand with few small pebbles and selenite crystals distributed throughout. Overlying the red unit is 1 1/2 ft of gray-green silt and clay with some sand and selenite, with a similar clay-mineral composition (NMP-413; table 2). This bed slopes upward and pinches out away from the basin and toward the southwest. These nonfossiliferous sediments, with high montmorillonite, moderate illite, and kaolinite and chlorite, have a composition that could be produced as detrital minerals from a source in the Ogallala Formation and Triassic rocks.

The overlying unit (NMP-414), 31/2 ft thick at the shoulder facing the playa, also pinches out to the southwest; the overlying gravels rest directly on red deposits that are continuous with the basal unit. This gray sand, with some silt and a few caliche nodules, contains a molluscan fauna (67), and is a nearshore deposit related to a lake level more than 25 ft higher than the present playa flat. The clay-mineral assemblage of this bed is unique among late Pleistocene basin deposits in eastern New Mexico because of the presence of attapulgite instead of sepiolite. The fossiliferous gray silt and sand are overlain at a sharp contact by a bed of gravels of smoothly rounded caliche pebbles sloping toward the basin at a lower angle than the underlying beds, and beveling them. This, in turn, is overlain by the uppermost unit of 6 ft gray sand containing a few small pebbles and a few fossil mollusks. This uppermost deposit (NMP-415) has a clay-mineral composition with about twice as much sepiolite as attapulgite, and minor amounts of montmorillonite, illite, and kaolinite. The fauna and physiographic setting indicates a Wisconsinan age for these deposits above the two basal beds, but an exceptional clay-mineral assemblage makes this assignment uncertain.

In southern Lea County the surficial deposits in parts of the area are eolian sand. In some places an older, stabilized cycle of eolian sand, with a strongly developed soil, has been truncated and overriden by a Holocene cycle of loose, tan, eolian sand (fig. 2f). In some places these young sands have migrated across slightly older basin deposits; locally, basin deposits have formed in interdune depressions.

Molluscan Fauna

GENERALITIES

In the course of the reconnaissance study of this area, fossil mollusks were obtained from about 25 localities, 20 of which are listed in table 1. Species of *Succinea* were recovered from several additional exposures. Fossiliferous deposits were found in terrace situations and in sediments deposited in undrained depressions (usually small) and judged to be the sites of ephemeral ponds. A few, however, were associated with larger and more permanent bodies of water, such as Laguna Gatuña.

Because of the sparsity of molluscan populations in the exposures studied, most collections were made by handpicking individual specimens from the surface of exposures in roadcuts, banks of small arroyos or larger drainageways, and in caliche pits. In a few instances, population density justified bulk sampling. Such samples were washed over a suitable screen, and the shells were recovered from the residue. Bulk sampling tends to increase the number of species recovered, but not by a large margin when handpicking is done carefully.

A striking characteristic of the molluscan assemblages in the southeastern part of New Mexico, as compared with those found farther north (Leonard and Frye, 1975) is that the population density is almost uniformly sparse, and most species are those adapted to survive arid climates. An unusual exception is the occurrence of *Somatogyrus subglobosus*, a branchiate gastropod restricted to permanent water because of its method of respiration, in terrace sediments at Locality 74. This species undoubtedly lived in the Pecos River. The terrace fauna here also yielded fragments of unionid shells; these animals are also obligate branchiates and demand permanent water. Other branchiate mollusks belonging to the pelecypod genera *Pisidium* and *Sphaerium* occur at a few places (table 1), but these animals are able to survive considerable periods without open water, buried in the mud, or in cavities such as crayfish burrows.

ACCOUNTS OF SPECIES

The 27 identifiable kinds of fossil mollusks found by us in southeastern New Mexico are listed below in systematic order, together with brief annotations. Synonomies are limited to a reference to the original description of the. species and to a standard current work on mollusca. Species collected are not illustrated here, but at least one of the references cited in the abbreviated synonomies refers to illustrations. Nearly all species were illustrated by Leonard and Frye (1975).

Phylum MOLLUSCA Class

GASTROPODA Order

CTENOBRANCHIATA

Family AMNICOLIDAE

GENUS *SOMATOGYRUS* Gill 1876

Somatogyrus subglobosus **(Say) 1825**

Paludina subglobosa Say 1825, Acad. Nat. Sci. Philadelphia Jour., vol. 5, p. 125.

Somatogyrus subglobosus (Say), La Roque 1968, Div. Geol. Surv. Ohio, Bull. 62, pt. 3, p. 404.

Somatogyrus subglobosus is a small operculate gastropod; the shell is about 9mm high and 7 to 8 mm wide. The species is typically part of the gastropod fauna of the Great Lakes region. This record is the second for New Mexico (Leonard and Fry, 1975), and to our knowledge, the first for streams that drain into the Gulf of Mexico west of Mississippi River. The living species occurs in running streams and also in lakes and permanent ponds.

Order PULMONATA

Suborder BASOMMATOPHORA

Family LYMNAEIDAE

GENUS *LYMNAEA* Larmarck 1799

Lymnaea (Stagnicola) palustris **(Muller) 1774**

Buccinum palustre Muller 1774, Verm. Terr. et Fluv. Hist., p. 131.

Lymnaea (Stagnicola) palustris (Muller), La Roque, 1968, p. 443, fig. 294.

Lymnaea palustris is a pulmonate gastropod, possessing a sort of lung fashioned from a compartment of the mantle and breathing mostly gaseous air. The type locality is in Europe, but the animal is circumboreal in distribution. In North America, *L. palustris* is distributed principally in northern United States and Canada. It is a hardy snail and able to live in small stagnant bodies of water. The species was recovered from only 2 localities in southeastern New Mexico (table 1).

Lymnaea (Fossaria) rustica Lea **1841**

Lymnaea rustica Lea 1841, Amer. Philos. Soc. Proc., vol. 2, p. 33.

Lymnaea (Fossaria) modicella rustica (Lea), La Roque, 1968, p. 473, fig. 327.

Lymnaea rustica is a relatively small gastropod with a high spiraled shell. It inhabits wet mud flats and the banks of streams, frequently out of contact with open water. *L. rustica* has been reported from New Mexico as a living species, but almost certainly does not occur in the southeastern part of the state.

Family PLANORBIDAE

GENUS *GYRA ULUS* Agassiz

1837 *Gyraulus parvus* **(Say) 1817**

Planorbis parvus Say 1817, Nicholson's Encyclopedia, 1st ed., vol. 2, pl. I. fig. 5 (no pagination).

Gyraulus parvus (Say), La Roque, 1968, Div. Geol. Surv. Ohio, Bull. 62, p. 491, pl. 12.

Gyraulus parvus is a small helicoid gastropod that lives in water, usually quiet streams or ponds, ordinarily not more than a few feet deep. It lives and feeds on aquatic vegetation, is widely distributed as a Pleistocene fossil in the southeastern part of New Mexico, and is often represented by large numbers of shells in the exposures observed.

Gyraulus circumstriatus (Tryon) 1866

Planorbis (Gyraulus) circumstriatus Tryon 1866, Amer. Jour. Conchology, vol. 2, p. 113.

Gyraulus circumstriatus (Tryon), La Roque 1968, Div. Geol. Surv. Ohio, Bull. 62, p. 493, pl. 12.

Gyraulus circumstriatus is similar in general appearance to *G. parvus*, but can be distinguished from that species by the fact that the whorls increase very gradually in diameter toward the aperture, while in *G. parvus* the increase is rapid. In general, *G. circumstriatus* is somewhat larger when mature, than *G. parvus*. Like *G. parvus, G. circumstriatus* is principally distributed in northern and northeastern United States; both species also occur in southern Canada.

GENUS *A RMIGER* Hartmann 1840

Armiger exigua Leonard 1972

Armiger exigua Leonard 1972, Nautilus, vol. 85, pt. 3, p. 82, fig. 1.

This tiny gastropod, allied to *A. crista*, but much smaller and differing from *A. crista* in many ways (Leonard, 1972), is apparently unknown as a living animal. *A. exigua* was described from deposits of Illinoian age in Henry County, Illinois, but the Pleistocene examples reported here, and by Leonard and Frye (1975), seem indistinguishable from the type forms. The ecological needs of this gastropod are, of course, unknown.

GENUS *HELISOMA* Swainson 1840

Helisoma antrosa (Conrad) 1834

Planorbis antrosus Conrad, 1834, Amer. Jour. Sci., 1st ser., vol. 25, p. 343.

Helisoma antrosa (Conrad), Baker 1928, Wisconsin Acad. Sci., Arts, and Letters, Bull. 70, pt. I, p. 317, pl. 19.

Helisoma antrosa is a planorbid gastropod of medium size, but generally somewhat smaller than *H. trivolvis*. The latter was recovered from several localities farther north (Leonard and Frye, 1975) but the present record of *H. antrosa* seems to be the first for New Mexico. In general the species is widely distributed in eastern United States, but has been reported as far west as southern California. It lives in ponds and lakes and in quiet streams.

Family PHYSIDAE

GENUS *PHYSA* Draparnaud 1801

Physa anatina Lea 1864

Physa anatina Lea 1864, Acad. Nat. Sci. Philadelphia Proc. 1864, p. 115.

Physa anatina Lea, La Roque 1968, Div. Geol. Surv. Ohio, Bull. 62, p. 535, pl. 13.

Members of the genus *Physa* are sometimes called tadpole snails because of the shape of the shell; shells are sinistral. Physid snails are notably variable, and reference to a species is often fraught with uncertainty. *Physa anatina* can live in almost any shallow body of water. It survives periods of desiccation, possibly by retreating to crayfish burrows, or to damp crevices in **the mud. It differs from** *P. gyrina* by its much more rotund and less streamlined whorls.

Physa gyrina Say 1821

Physa gyrina Say 1821, Acad. Nat. Sci. Philadelphia Jour., vol. 2, p. 171.

Physa gyrina Say, La Roque, 1968, Div. Geol. Surv. Ohio, Bull. 62, p. 541, fig. 396.

Physa gyrina is more widely distributed in the United States than *P. anatina,* but neither species seems to occur in the living gastropod fauna of New Mexico. Like *G. anatina, P. gyrina* lives in quiet, shallow waters and can also survive periods of desiccation in a manner similar to that of *P. anatina.* For some unknown reason, the two species were not recovered from the same locality at any place in southeastern New Mexico.

Suborder STY LOMMATOP

HORA Family POLYGYRIDAE

GENUS *POLYGYRA* Say 1818

Polygyra texasiana (Moricand) 1833

Helix (Helicodonta) texasiana Moricand 1833, Mem. Soc. Phys. et Hist. Nat. de Geneve, 6:538, p1. I. fig. 2 (Mexique, dans la province de Texas).

Polygyra texasiana (Moricand), Pilsbry, 1940 Land Mollusca North America, vol. I, pt. 2, p. 617, fig. 394 a-c.

Pilsbry (1940, p. 619) recognized a subspecies, *texasensis* of *P. texasiana,* but the 2 specimens here reported from Locality 75 seem best referred to the type form. Pilsbry does not report the living species from New Mexico, and fossils were not recovered by Leonard and Frye (1975). It has been widely reported from Texas, Arkansas, and Louisiana. The living shells are banded, but no remnant of these bands remains on the specimens in hand.

Family ZONITIDAE

GENUS *HA WAIIA* Gude 1911

Hawaiia minuscula (Binney) 1840

Helix minuscula Binney 1840, Boston Jour. Nat. Hist. 3:435, pl. 22, fig. 4.

Hawaiia minuscula (Binney), Pilsbry 1946, Land Mollusca North America, vol. 2, pt. I, p. 420, fig. 228-229. Philadelphia.

This minute gastropod is well adapted to xeric conditions and is widespread in Pleistocene deposits on the Great Plains. Pilsbry (1946, p. 424) recognizes a subspecies, *neomexicana,* based principally on fine sculpture of the shell, but our specimens seem better referred to the typical taxa. *H. minuscula* is often seen in greenhouses and is undoubtedly dispersed in commerce of nursery stock and other items.

Family ENTODONTIDAE

GENUS *HELICODISCUS* Morse 1864

Helicodiscus singleyanus (Pilsbry) 1890

Zonites singleyanus Pilsbry 1890, Proc. Acad. Nat. Sci. Philadelphia, p. 84, for 1889.

Helicodiscus singleyanus (Pilsbry) 1948, Land Mollusca North America, vol. 2, pt. 2, p. 636, fig. 346. Philadelphia.

This minute gastropod, measuring a little more than 2 mm in diameter, is superficially similar to *Hawaiia minuscula*, but is much less common in the area of this report. The living species has been reported from Doña Ana and Luna Counties in New Mexico, as well as in Arizona, Colorado, and in other states as far east as Pennsylvania. In our studies we found *H. singleyanus* at only 2 localities, one also having *Hawaiia minuscula.*

Family SUCCINEIDAE

GENUS *SUCCINEA* Draparnaud 1801

Succinea grosvenori Lea 1864

Succinea grosvenori Lea 1864, Proc. Acad. Nat. Sci. Philadelphia, p. 109.

Succinea grosvenori Lea, Pilsbry 1948, vol. 2, pt. 2, p. 819, fig. 444, 452.

The systematics of the Succineidae are not yet satisfactory; some species are difficult to determine, especially from the shell alone. The shells here referred to *S. grosvenori* compare favorably with living and fossil shells from the Gallinas River valley a few miles below Las Vegas, San Miguel County, New Mexico. *S. grosvenori* is widespread as a Pleistocene fossil in eastern New Mexico and on the Great Plains generally. In the area of this report, the species occurs more frequently than any other by a wide margin.

Succinea gelida F. C. Baker 1927

Succinea grosvenori gelida Baker 1927, Nautilus, vol. 40, p. 118.

Succinea grosvenori gelida Baker, Pilsbry 1948, Land Mollusca North America, vol. 2, pt. 2, p. 823, fig. 444.

This small succineid gastropod has been referred by various authors to *S. avara* or to *S. vermeta* but its true identity remains in doubt. In any case, there seems no reason to consider *S. gelida* a subspecies of *S. grosvenori*, with, which it does not intergrade, althought it often occurs with *S. grosvenori* in Pleistocene deposits. As a matter of fact, we believe that it probably is a species of the genus *Catenella. S. gelida* is widespread in our area, although less so than *S. grosvenori.*

Succinea luteola Gould 1848

Succinea luteola Gould 1848, Proc. Boston. Soc. Nat. Hist., vol. 3, p. 37.

Succinea luteola Gould, Pilsbry, 1948, Land Mollusca North America, vol. 2, pt. 2, p. 828, fig. 450. Philadephia.

Succinea luteola is typically larger and more elongate than *S. grosvenori.* Living specimens have been collected from New Mexico in San Miguel County, but the principal distribution is south of New Mexico, in Texas and Mexico. Records from Louisiana, however, are most numerous. It seems less adapted to xeric extremes than *S. grosvenori*, and, by implication, *S. gelida.*

Family PUPILLIDAE

GENUS ***GASTROCOPTA*** Wallaston 1878

Gastrocopta tridentata (Leonard) 1946

Columella tridentata Leonard 1946, Nautilus, vol. 60, p. 20, pl. 3.

Gastrocopta tridentata (Leonard), Pilsbry, 1948, Land Mollusca North America, vol. 2, pt. 2, p. 880, fig. 473.

This enigmatic species was previously known only from a single locality in western Kansas, from deposits in the "lower" Pleistocene. Its occurrence here in very late Pleistocene deposits is surprising.

Gastrocopta contracta (Say) 1822

Pupa contracta Say, 1822, Jour. Acad. Nat. Sci. Philadelphia, vol. 2, p. 374.

Gastrocopta contracta (Say), Pilsbry 1948, Land Mollusca North America, vol. 2, pt. 2, p. 880, fig. 474.

Gastrocopta contracta is a minute pupillid gastropod, widely distributed in eastern United States. It was not reported by Leonard and Frye (1975) in east-central New Mexico, but occurs at 4 localities in the area of this report (table 1). In our experience, *G. contracta* is a species of rocky, wooded slopes, but sometimes occurs locally in leaf mold at lower elevations.

Gastrocopta pentodon (Say) 1821

Vertigo pentodon Say 1821, Jour. Acad. Sci. Philadelphia, vol. 2, p. 376.

Gastrocopta pentodon (Say), Pilsbry, 1948, Land Mollusca North America, vol. 2, pt. 2, p. 886, fig. 477.

Gastrocopta pentodon has been reported living in New Mexico and was recorded as a fossil in east-central New Mexico by Leonard and Frye (1975). It normally lives on wooded slopes, in leaf mold in brushy areas, or in grassy slopes. Superficially, it resembles *G. contracta*, but the apertural denticles are completely different, and the shape is distinctive.

Gastrocopta cristata (Pilsbry and Vanatta) 1900

Bifidaria procera cristata Pilsbry and Vanatta, 1900, Proc. Acad. Nat. Sci. Philadelphia, p. 595, pl. 22.

Gastrocopta cristata (Pilsbry and Vanatta) Pilsbry, 1948, Land Mollusca North America, vol. 2, pt. 2, p. 911, fig. 493.

This minute pupillid occurs at 4 localities in southeastern New Mexico (table 1) and was reported at numerous places in east-central New Mexico by Leonard and Frye (1975). It is a western species, distributed from eastern Oklahoma to Arizona, Texas, and New Mexico.

Gastrocopta pellucida hordeacella (Pilsbry) 1890

Pupa hordeacella Pilsbry 1890, Proc. Acad. Nat. Sci. Philadelphia, p. 44, pl. I.

Gastrocopta pel/ucida hordeacella (Pilsbry), Pilsbry, 1948, Land Mollusca North America, vol. 2, pt. 2, p. 913, fig. 494.

In the area of this report, a single specimen was recovered from one locality (74A), but is typical of the minute gastropods assigned to this species. The systematics of *G. p. hordeacella* and *G. p. parvidens* needs clarification because, while Pilsbry in his monograph (1948) recognizes these two subspecies, he does not list the species *G. pellucida.* This form was not reported from east-central New Mexico by Leonard and Frye (1975).

GENUS ***PUPOIDES*** Pfeiffer 1854

Pupoides albilabris (C. B. Adams) 1841

(Pupa) albilabris "Wards letter", C. B. Adams, 1841, Amer. Jour. Sci., vol. 40, p. 271.

Pupoides albilabris (C. B. Adams), Pilsbry, 1948, Land Mollusca North America, vol. 2, pt. 2, p. 921.

Pupoides albilabris occurs from eastern United States to Arizona. The species is somewhat variable in size and form; the white, thickened, reflected lip of the aperture is characteristic. It is widely distributed as a Pleistocene fossil in eastern New Mexico, but occurs at only a few places in living colonies, at high elevations.

GENUS *PUPILLA* Leach 1831

***Pupilla blandi* Morse 1865**

Pupilla blandi Morse 1865, Ann. Lyc. Nat. Hist. New York, vol. 8, p. 5, fig. *8.*

Pupilla blandi Morse, Pilsbry, 1948, Land Mollusca North America, vol. 2, pt. 2, p. 929, fig. 502.

Pupilla blandi is a montane species occurring as a Pleistocene fossil on the High Plains of western Kansas and elsewhere. It is especially numerous as a living species in New Mexico west of the Rio Grande, but rather rare in our collections in southeastern New Mexico, though found abundantly a little farther north (Leonard and Frye, 1975).

***Pupilla muscorum* (Linne) 1758** *Turbo*

muscorum Linne 1758, Syst. Nat. 10th Ed., p. 767.

Pupilla muscorum (Linne), Pilsbry, 1948, Land Mollusca North America, vol. 2, pt. 2, p. 933, fig. 503.

Pupilla muscorum is distributed as a living gastropod from northeastern North America to Arizona; in the old world this gastropod extends from northern Europe and Asia to North Africa. Typically it lacks the apertural denticles so common in *P. blandi* and tends to be more elongate. *P. muscorum* is widespread as a loess fossil over the Great Plains and even east of the Mississippi.

Family VALLONIDAE

GENUS *VALLONIA* Risso 1826

***Vallonia gracilicosta* Reinhardt 1883**

Vallonia gracilicosta Reinhardt 1883, Sitzungs-Ber. Gest. Naturforsch, Fruende, Berlin, p. 42.

Vallonia gracilicosta Reinhardt, Pilsbry, 1948, Land Mollusca North America, vol. 2, pt. 2, p. 1028, fig. 549. Philadelphia.

The vallonids are minute gastropods having helically spiraled shells bearing riblets, although some species are almost smooth. The species *V. gracilicosta* has been reported from several counties in New Mexico; some records are of drift shells that may have been fossils. *V. gracilicosta* superficially resembles but differs from *V. cyclophorella* which it superficially resembles closely, by its *(V. gracilicosta)* reflected lip, thickened by a white callus. *V. gracilicosta* occurs west of the Mississippi River from Michigan, South Dakota and Wyoming, to Arizona, but is much more widely distributed as a Pleistocene fossil.

***Vallonia cyclophorella* Sterki 1893**

Vallonia cyclophorella Sterki 1892, Nautilus, vol. 5, p. 101.

Vallonia cyclophorella Sterki, Pilsbry, 1948, Land Mollusca North America, vol. 2, pt. 2, p. 1035, fig. 544. Philadelphia.

Vallonia cyclophorella is the most widespread of the montane species of *Vallonia*, often occurring with *V. gracilicosta* or *V. albula*. **Both** *V. gracilicosta* **and** *V. cyclophorella* occur in Pleistocene deposits in eastern New Mexico, but are much less common in southeastern localities than in those farther north (Leonard and Frye, 1975).

Class PELECYPODA

Order EULAMELLIBARCHIA

Family SP HAERIIDAE

GENUS *SPHAERIUM* Scopoli 1777

***Sphaerium transversum* (Say) 1829**

Sphaerium transversum (Say), Herrington. 1962, Misc. Publ. Univ. Michigan, No. 118, p. 29, Pl. 2, fig. 6. Ann Arbor.

Herrington (1962), who notes that *S. transversum* is widely distributed from Canada to Mexico, does not mention records from New Mexico. We have not found it at many localities in eastern New Mexico; but the specimens we have, seem to be typical of the species. These small pelecypods are branchiates, but generally seem able to survive periods of desiccation, although all species cannot do this.

GENUS *PISIDIUM* Pfeiffer 1821

***Pisidium compressum* Prime 1851**

Pisidium compressum Prime. Herrington, 1962. Misc. Publ. Univ. Michigan, No. 118. p. 35, Pl. 5, fig. 2, Pl. 7, fig. 14. Ann Arbor.

While ***P.*** *compressum* is widespread in North America, both as a living animal and as a fossil known from both Pliocene and Pleistocene deposits, the species is not common in eastern New Mexico. In southeastern New Mexico, we found it sparingly at only 2 localities. *P. compressum* is a much smaller pelecypod than *S. transversum* and like it, a branchiate animal requiring water for respiration except for periods of apparent dormancy during dry intervals. *P. compressum* occurs in lakes to depths of 20 meters, in shallow ponds, and in streams.

Summary and Conclusions

During the reconnaissance of southeastern New Mexico, 3 outliers of Ogallala Formation were sampled. Although in two of the three cases the uppermost clay-mineral Zones 4 and 5 (pisolitic limestone) had been removed by erosion, clay-mineral Zones 2 and 3, defined farther north (Frye and others, 1975), were clearly identifiable by the occurrence of attapulgite, sepiolite, and opal in association with typical lithologies.

Without exception the Wisconsinan pond and lake deposits sampled in southern Lea County contain sepiolite—in contrast to the pond and lake deposits of the High Plains farther north in Lea County, Roosevelt County, and southern Curry County. In the High Plains area, sepiolite occurs only in deposits of depressions in the relatively low-lying belts crossing the plains from west to east, particularly in the floor of Portales valley and the linear east-west sag north of Milnesand (Glass and others, 1973), and not in the few depressions rimmed by the upper part of the Ogallala Formation. Furthermore, sepiolite does not occur in the depression fills associated with Pecos valley terraces or the dissected western end of Portales valley. These relationships suggest that sepiolite forms in water-table ponds during times of increasing desiccation when such ponds become areas of ground-water discharge with increasing alkalinity; not in ponds above the water table where water leaves the pond by downward percolation, or in ponds fed only by surface runoff. We conclude that sepiolite is not now forming in the intermittently flooded playa flats common in the region.

Clay-mineral assemblages in the deposits of the Wisconsinan terraces of this area are similar to those in the Wisconsinan terraces northward at least as far as Santa Rosa. This observation confirms the physiographic evidence of continuity of these terraces along Pecos River in approximately its present position during Wisconsinan time, and that integration of the present Pecos River took place after abandonment of the Kansan Portales valley (Leonard and Frye, 1975), and before the Wisconsinan.

This study of the Pleistocene mollusks of southeastern New Mexico was not thorough and exhaustive. Collections were made at 20 localities during the brief period of field work in the summer of 1973; 2 additional localities previously reported (Leonard and Frye, 1975) have been added to these because of their geographical position. In all, some 30 species of mollusca were noted in these collections (table 1). Fossiliferous exposures are relatively sparse in southeastern New Mexico; and none of those studied contained as varied a fauna as some of the localities studied farther north (Leonard and Frye, 1975), nor were populations as dense.

Only a few species collected in southeastern New Mexico were not seen father north. *Gastrocopta pellucida hordeacella* occurs so rarely that a chance occurrence cannot be given much importance. *Helisoma antrosa* has not been found farther north in New Mexico, but was collected at 2 localities in the southeast. It should have been expected farther north, but why it has not been collected there is not clear. *Lymnaea rustica* was identified in the southeast, but not in the east-central collections. The distinction between *humilis* and *rustica*, however, is so subtle that little significance, can be attached to their respective occurrences. Only *Polygyra texasiana is* of some interest in a comparison of the molluscan faunas in the 2 sections of the state. Our record seems to be the second for New Mexico, according to Pilsbry (1940, p. 620). J. D. Tinsley collected *Polygyra* as a fossil "from a bed of white marl, three or four feet below the surface" on South Spring Creek near Roswell. *Polygyra texasiana* is a southern species with type locality at Brownsville, Texas, but has been found in the lower Pecos River valley in Texas, living under the drooping dead leaves at the base of *Yucca* plants. To our knowledge, living examples have never been collected in New Mexico, indicating that environmental conditions for this gastropod are less favorable now than they have been in the past.

Slightly more than half of the Pleistocene localities studied in southeastern New Mexico are lacustrine; the remainder consist of terrace deposits. A careful comparison of the molluscan faunas derived from the 2 sedimentary types reveals, however, no significant differences in the respective faunal assemblages. In the same manner, faunal assemblages were compared according to predominate characteristics of the clay-mineral assemblages in the matrix, but again significant differences were not found. Apparently the mollusks that inhabited this region of New Mexico in late Pleistocene times were so generally adapted that the local differences in environment were not sufficient to limit their distribution.

Two striking differences are noted between the late Pleistocene faunal assemblages reported here and the living molluscan faunas of the region. The first is the relative richness of the late Pleistocene assemblages as compared with what is known of the living molluscan fauna of southeastern New Mexico. Little is really known of the living mollusks of the region, but our observations indicate an extremely sparse modern molluscan fauna in southeastern New Mexico. Aside from *Yucca* and such cacti as *Opuntia*, cover for terrestrial mollusks is sparse and limited to the brushy areas along the Pecos River.

The second striking characteristic of the late Pleistocene molluscan fauna in southeastern New Mexico is the almost total absence of aquatic mollusks in the living fauna. Probably a few unionids exist in Pecos River, and perhaps some sphaeriid clams occur in local environments in that stream, but we saw none of either. Strangely, we observed no aquatic gastropods such as *Physa* or *Lymnaea* in stocktanks and in artificial reservoirs, although these genera, and even sphaeriid clams usually colonize these local environments without delay. Furthermore, in certain reaches of Pecos River, the local conditions seemed ideal for a branchiate gastropod such as *Somatogyrus subglobosus*, that is, fast, well-aerated, clear water flowing over stones and gravel upon which abundant growth of algae occurred. Possibly the water has been contaminated with herbicides and/or insecticides inimicable for *Somatogyrus* and other aquatic mollusks, but data on this possible factor are not available to us. The apparent absence of such hardy animals as *Physa*, *Helisoma*, and *Lymnaea* in the modern fauna is striking indeed.

From our observations and from other data available to us, the southeastern part of New Mexico must have been much better watered in late Pleistocene times, and had a much better ground cover than at present. Severe grazing has altered the local environment, greatly reducing terrestrial mollusks in that ground cover. The lack of good ground cover and permanent water, together with the rigorous, arid climate are simply not conducive to the growth of molluscan populations.

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Appendix—Location of faunas and lithologic samples

General locations are shown in fig. 1, field descriptions are in field notes on file at New Mexico Bureau of Mines & Mineral Resources.

Fauna No.	Location
19	NW¼NE¼ sec. 9, T. 17 S., R. 32 E., Lea
34	Center NE¼ sec. 27, T. 15 S., R. 26 E., Chaves
60	SW¼SW¼ sec. 1, T. 21 S., R. 37 E., Lea
61	NE¼SE¼ sec. 9, T. 26 S., R. 37 E., Lea
62	SW¼SW¼sec. 34, T. 18 S., R. 36 E., Lea
63	NE¼SE¼ sec. 21, T. 20, S., R. 37 E., Lea
64	SE¼SW¼ sec. 17, T. 25 S., R. 37 E., Lea
65	NE¼ sec. 12, T. 25 S., R. 35 E., Lea
66	NE¼SE¼ sec. 6, T. 20 S., R. 34 E., Lea
67	NW¼NE¼ sec. 19, T. 20 S., R. 33 E., Lea
68	NW¼NW¼ sec. 16, T. 26 S., R. 32 E., Lea
69	NW¼NE¼ sec. 21, T. 24 S., R. 33 E., Lea
70 and 70A	SE¼ sec. 23, T. 26 S., R. 28 E., Eddy
71	NE¼NE¼ sec. 8, T. 26 S., R. 29 E., Eddy
72	NW¼NE¼ sec. 10, T. 25 S., R. 28 E., Eddy
73	SE¼NE¼ sec. 28, T. 24 S., R. 29 E., Eddy
74	SE¼SE¼ sec. 11, T. 21 S., R. 26 E., Eddy
74A	E¼SE¼ sec. 11, T. 21 S., R. 26 E., Eddy
75	SW¼SE¼ sec. 2, T. 20 S., R. 26 E., Eddy
76	SW¼SE¼ sec. 3, T. 20 S., R. 26 E., Eddy
77	SW¼SE¼ sec. 15, T. 18 S., R. 26 E., Eddy

Lithologic Samples No.	Location
NMP-196, 197 (Fauna 34)	Center NE¼ sec. 27, T. 15 S., R. 26 E., Chaves
NMP-200, 201	SW¼SE¼ sec. 18, T. 18 S., R. 34 E., Lea
NMP-393	SE¼NE¼ sec. 27, T. 20 S., R. 38 E., Lea
NMP-394 (Fauna 60)	SW¼SW¼ sec. 1, T. 21 S., R. 37 E., Lea
NMP-395 (Fauna 61)	NE¼SE¼ sec. 9, T. 26 S., R. 37 E., Lea
NMP-396, 397 (Fauna 62)	SW¼SW¼ sec. 34, T. 18 S., R. 36 E., Lea
NMP-398-401	SW¼ sec. 23, T. 21 S., R. 36 E., Lea
NMP-402, 403	NE¼ sec. 6, T. 25 S., R. 37 E., Lea
NMP-404-406 (Fauna 64)	SE¼SW¼ sec. 17, T. 25 S., R. 37 E., Lea
NMP-407-410	SE¼ sec. 19, T. 25 S., R. 35 E., Lea
NMP-411 (Fauna 66)	NE¼SE¼ sec. 6, T. 20 S., R. 34 E., Lea
NMP-412-415 (Fauna 67)	NW¼NE¼ sec. 13, T. 20 S., R. 33 E., Lea
NMP-416	NW¼ sec. 3, T. 23 S., R. 29 E., Eddy
NMP-417 (Fauna 68)	NW¼NW¼ sec. 16, T. 26 S., R. 32 E., Lea
NMP-418-421	SW¼SE¼ sec. 18, T. 18 S., R. 34 E., Lea
NMP-422 (Fauna 72)	NW¼NE¼ sec. 10, T. 25 S., R. 28 E., Eddy
NMP-422C	NW¼NE¼ sec. 14, T. 23 S., R. 28 E., Eddy
NMP-423 (Fauna 74)	SE¼SE¼ sec. 11, T. 21 S., R. 26 E., Eddy
NMP-424 (Fauna 75)	SW¼SE¼ sec. 2, T. 20 S., R. 26 E., Eddy
NMP-425, 426	NE¼SE¼ sec. 7, T. 17 S., R. 27 E., Eddy
NMP-427 (Fauna 77)	SW¼SE¼ sec. 15, T. 18 S., R. 26 E., Eddy

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