MOLLUSCAN FAUNA AND LACUSTRINE SEDIMENTS IN SANPETE VALLEY NEAR MANTI, SANPETE COUNTY, UTAH

SENIOR THESIS

Presented in Partial Fulfillment of the Requirements for the Degree Bachelor of Science

by

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INTRODUCTION

PURPOSE OF INVESTIGATION. The aim of the study is to determine, if possible, the paleoecology of a deposit west of Manti, Utah, as well as the geomorphology of the deposit.

LOCATION OF DEPOSIT. The deposit under investigation is located in Sanpete County, Utah, on Manti Quadrangle, 7.5 minute series, in Sections 23, 24, 25, 26, 27 and 30 and 34, Township 17 South, Range 2 East, and Sections 3 and 4, Township 16 South, Range 2 East. This deposit of lacustrine origin is referred to here as the Manti deposit. The uppermost part of the deposit that contains fossils is at 5430 feet above sea level on the west side of the valley, and the beach area above this terminates at approximately 5450 feet. On the east side of the valley fossil clay is at 5445 feet, but a beach level there could not be established. The deposit in this paper is labeled Qlb and Qlc on the map in Fig. 2.

ACKNOWLEDGEMENTS. Dr. Sidney E. White suggested the investigation and Dr. Aurèle La Rocque helped in the identification of the molluscan fauna. Sincere thanks are hence owed both of these professors.

GEOLOGY OF STUDY AREA

The area of study is bounded on the west by the Gunnison Plateau, a broad gentle syncline with a 4° plunge to the south. The front of the Gunnison Plateau is sharply folded, with some overturned beds in the Tertiary North Horn. On the east it is

Fig. I INDEX MAP

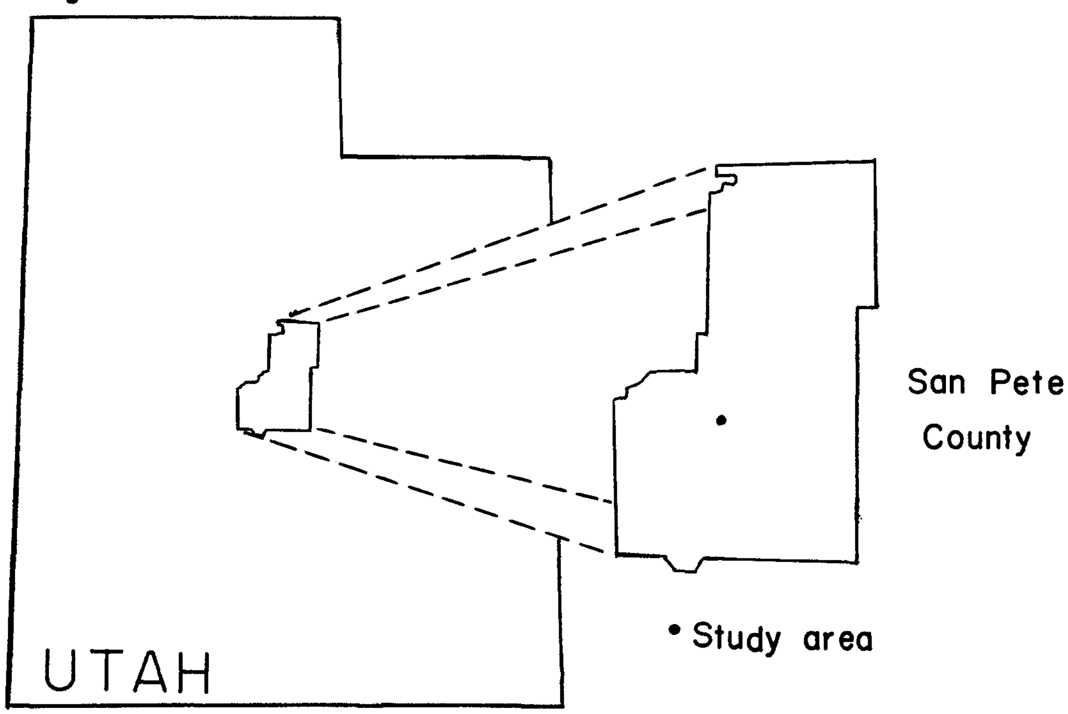
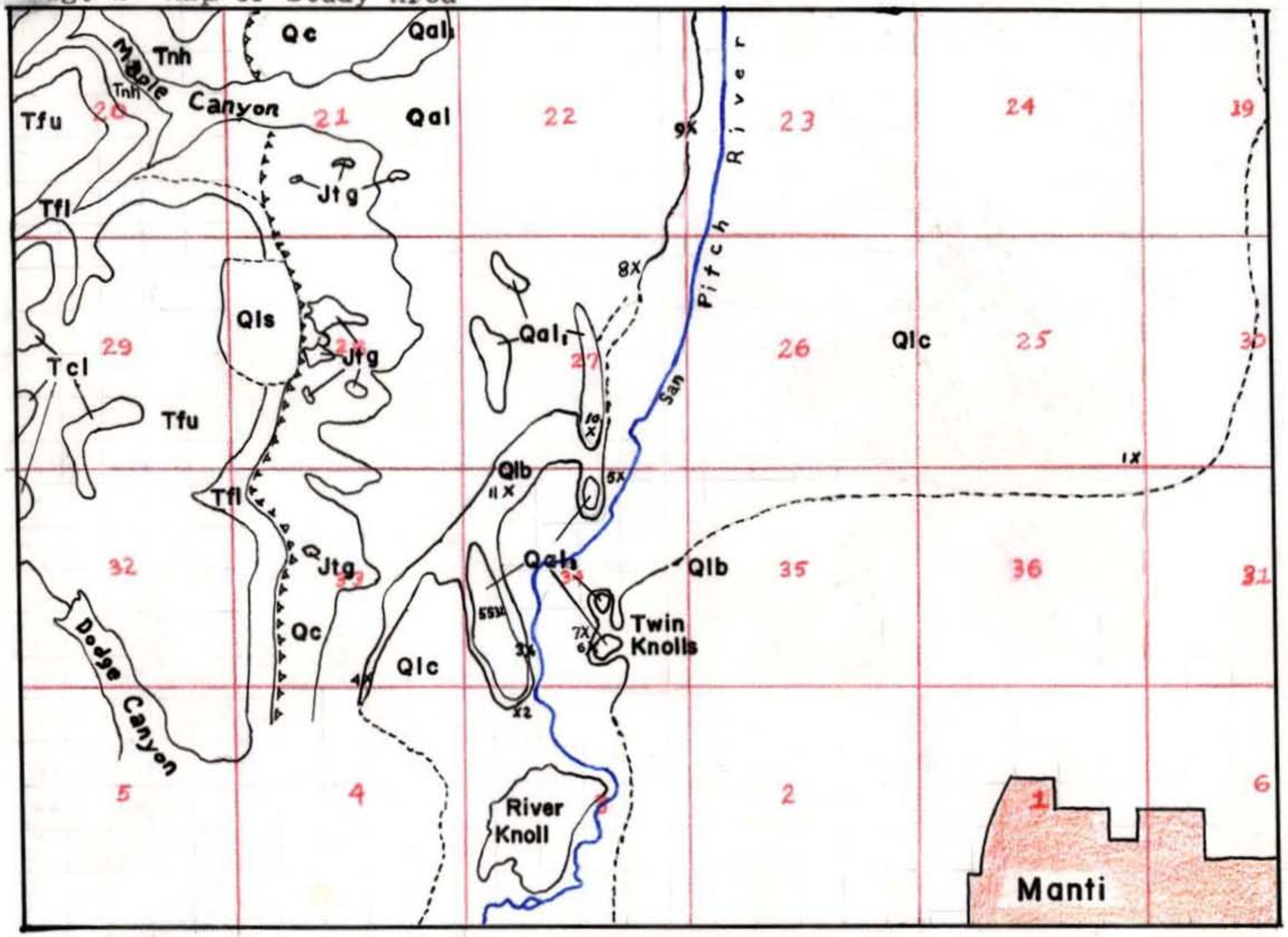


Fig. 2 Map of Study Area



Qls Landslides and other mass movement
Qal_2 Younger alluvium
Qal_1 Older alluvium
Qlb Lake Sterling beach ?
Qlc Lake Sterling clay
Qc Colluvium
Tcl Lower Colton

Tfu Upper Flagstaff
Tfl Lower Flagstaff
Tnh North Horn
Jtg Twist Gulch
1 X Sample localities

bounded by the Wasatch Monocline, which lies on the western edge of the Wasatch Plateau.

The Manti deposit is associated with other beds of Quaternary age. The deposit is exposed except at the mouths of Maple Canyon South and Dodge Canyon where alluvium (Qal_2) covers the deposit. This alluvium from the canyons is composed of angular gravels and cobbles of limestone and chert, probably from the Tertiary Flagstaff and Green River formations, interbedded with unconsolidated red silts, probably from the Upper Colton of Tertiary age.

The base of the deposit is not exposed. In about 1930, when the San Pitch River was rerouted through this area, a ditch was excavated about 8 feet deep. This excavation did not reach the base of the deposit. Therefore the deposit is at least 20 feet in thickness. There does not appear to be any bedding in the lacustrine sediments. Judging from the sequence of formations in the area, the lacustrine sediments probably rest upon Jurassic Arapien shale.

COMPOSITION OF FAUNA

The mollusca of the Manti deposit were collected at sampling sites shown in Fig. 2. Most of the collections came from the western side of the deposit.

Of the eight species in Table 1, one was a Bivalvia, one a freshwater gill-breathing gastropod, five freshwater lung-breathing gastropoda, and one a terrestial gastropod. Two occurred in every sample that was fossiliferous and two occurred in all but one of the samples (Table 2).

Table 1. SPECIES OF MOLLUSCA OCCURRING IN MANTI DEPOSIT

<u>Bivalvia</u>

Pisidium nitidum pauperculum Sterki

<u>Freshwater Gill-breathing Gastropoda</u>

Valvata humeralis californica Pilsbry

<u>Freshwater Lung-breathing Gastropoda</u>

Gyraulus Parvus (Say)

Fossaria parva (Lea)

Physa gyrina Say

Promenetus exacuous (Say)

Helisoma trivolvis (Say)

<u>Terrestial Gastropoda</u>

Oxyloma retusa (Lea)

Table 2. HORIZONTAL DISTRIBUTION OF SPECIES

	Sample Collections								
	1	2	3	4	5	6	7	8	9
Pisidium nitidum pauperculum Sterki	x	x	x				x		
Valvata humeralis californica Pilsbry	x	x	x		x		x		x
Gyraulus parvus (Say)	x	x	x		x		x		x
Fossaria parva (Lea)		x	x		x		x		x
Physa gyrina Say			x		x		x		
Promenetus exacuous (Say)		x	x		x		x		x
Helisoma trivolvis (Say)			x		x		x		
Oxyloma retusa (Lea)			x		x				

PALEOECOLOGY

The Manti deposit is composed of seven freshwater species and one land gastropod. The land gastropod, Oxyloma retusa (Lea), occurs in only collections 3 and 5 and constitutes a very small percentage in each of these collections. Its presence could be expected since the environment it lives in is moist. Valvata humeralis californica Pilsbry and Gyraulus parvus are the most numerous in all the collections. Frequency of occurrence of V. humeralis californica ranges from 17.3 in collection 5 to 48.9 in collection 7, and that of G. parvus from 10.6 in collection 7 to 69.5 in collection 5.

The ecology of each of the species has been condensed and summarized from the following authors: Baker, 1928; Clark, 1961; Henderson, 1929; La Rocque, 1952, 1966; Leonard, 1950; Mowery, 1961; Taylor, 1960; Reynolds, 1959; and Zimmerman, 1960.

Bivalia

Pisidium nitidum pauperculum Sterki. This species lives in ponds, small and large lakes in shallow water. The bottom may be sand, clay, mud. It usually lives in shallow water probably from 1 to 5 m. The depth would be for a more dense population. It can live in water as deep as 39.5 m. The pH for this species is 7.0 to 8.0 and the fixed carbon dioxide 9.3 to 24.73 ppm. It burrows into the bottom sediments and feeds on detritus and plankton.

Freshwater Gastropoda

Valvata humeralis californica Pilsbry. Very little information is available for this species in the literature. Henderson (1929) believes that the species found in the Grand Coulee district of Washington is of Pleistocene lacustrine origin. It also lives in lakes, ponds, and streams. V. tricarinata is abundant in weedy places on either sandy or muddy bottoms. It would seem likely that V. humeralis californica Pilsbry would inhabit environments similar to those of other Valvatidae. The environment would be shallow water with a pH of at least 7.1 with a fixed carbon dioxide of 8 ppm. minimum.

Gyraulus parvus (Say). This species inhabits quiet, shallow bodies of water 0.3 to 2.2 m. deep, mainly those of small size, on mud, sandy mud, sand, gravel, or boulder bottom; also on logs and vegetation. It lives in areas of abundant vegetation which are well protected. It has a slight burrowing reaction when faced with desiccation. It can live for a time on various substrata as long as moisture is present. The pH is 7.0 to 8.16; fixed carbon dioxide 8.16 to 30.56 ppm.

Fossaria parva (Lea). This species lives in wet, marshy places, generally out of the water, on sticks, stone, or muddy flats. It is more prone to leave the water than any other species of the family. For other species of the family the pH is 5.86 to 8.37; fixed carbon dioxide 10.65 to 18.87 ppm.

Physa gyrina Say. This is a shallow water species, usually 0.3 m. deep, that inhabits swampy, slow moving, and stagnant bodies of water that have sandy silt or mud bottoms. The optimum conditions for its survival are shallow water which is unshaded; few or no enemies such as fish and some birds; a minimum amount of debris; protection from waves and currents; moderate growth of pondweed; and well-aerated water. It is usually found on the upper side of pond lily leaves. They can live for a time on almost any substratum. P. gyrina lives upon both animal and vegetable food, either fresh or partly decayed. The pH is 7.1 to 8.37; fixed carbon dioxide 9.5 to 22.75 ppm.

Promenetus exacuous (Say). This is another quiet, shallow water species. It lives on the underside of lily pads, on sticks, and on stones along the margins of ponds just under the water. The area is more or less marshy with shallow water with a soft mud bottom. In streams it is always found on mud flats in quiet water, not in more rapid parts of the streams. The types of vegetation it lives on are varied. P. exacuous lives in water whose pH varies from 7.0 to 7.64 and whose carbon dioxide content ranges from 9.3 to 22.5 ppm. The most important factors in the habitat seem to be the preference for cold water and the presence of vegetation.

Helisoma trivolvis. This species is an inhabitant of quiet, shallow, stagnant water. It flourishes in ponds and sloughs, even though they may be choked with vegetation or polluted with decaying organic materials and is invariably absent from flowing streams. It also lives behind beach barriers, in large open swamps, and at the edges of lakes and streams. The pH of the water in which it lives varies from 6.6 to 8.37 and the carbon dioxide content ranges from 7.5 to 30.56 ppm. The bottoms of the marshes, swampy shores, or stagnant pools are mud or fine sandy silt with the water depth up to 2 m. but generally less than 0.6 m. deep.

Terrestial Gastropoda

Oxyloma retusa (Lea). This is a species of marshes and other wet places. It commonly lives on mud flats above high water level along swampy shores, caused by raising of the water level in the lake or pond. It is also found upon partly submerged sticks and on rotting weeds.

REGISTER OF COLLECTIONS

(1) North of Manti, SE $\frac{1}{4}$, SE $\frac{1}{4}$ sec. 25, T. 17 S., R. 2 E., Sanpete County, Utah; depth 6"; 1968; 7 specimens.

Species	No. Species	Per cent Indiv.
Gyraulus parvus (Say)	4	57.1
Valvata humeralis californica Pilsbry	2	28.6
Pisidium nitidum pauperculum Sterki	1	14.3

(2) NW $\frac{1}{4}$, NW $\frac{1}{4}$ sec. 3, T. 17 S., R. 2 E.; depth 54"; 1968; 115 specimens.

Species	No. Species	Per cent Indiv.
Valvata humeralis californica Pilsbry	67	58.2
Pisidium nitidum pauperculum Sterki	1	0.9
Fossaria parva (Lea)	5	4.3
Promenetus exacuous (Say)	1	0.9
Gyraulus parvus (Say)	41	36.7

(3) SE $\frac{1}{4}$, SW $\frac{1}{4}$ sec. 34, T. 17 S., R. 2 E.; depth 22 "; 1968; 336 specimens.

Species	No. Species	Per cent Indiv.
Oxyloma retusa (Lea)	4	1.2
Helisoma trivolvis (Say)	4	1.2
Fossaria parva (Lea)	8	2.4

Gyraulus parvus (Say)	190	56.5
Promenetus exacuous (Say)	36	10.7
Physa gyrina Say	4	1.2
Pisidium nitidum pauperculum Sterki	1	0.3
Valvata humeralis californica Pilsbry	89	26.5

(4) SW ¼, SE ¼ sec. 33, T. 17 S., R. 2 E.; depth 12"; 1968; no fossils.

(5) NW ¼, SE ¼ sec. 34, T. 17 S., R. 2 E.; depth 15"; 1968; 1062 specimens.

Species	No. Species	Per cent Indiv.
Physa gyrina Say	2	0.2
Valvata humeralis californica Pilsbry	184	17.3
Oxyloma retusa (Lea)	2	0.2
Promenetus exacuous (Say)	58	5.4
Helisoma trivolvis (Say)	8	0.7
Fossaria parva (Lea)	71	6.7
Gyraulus parvus (Say)	738	69.5

(6) NW ¼, SE ¼ sec. 34, T. 17 S., R. 2 E.; depth 20" on side of southern knoll of Twin Knolls; 1968; no fossils.

(7) NW ¼, SE ¼ sec. 34, T. 17 S., R. 2 E.; depth 20"; 1968; 222 specimens.

Species	No. Species	Per cent Indiv.
Valvata humeralis californica Pilsbry	133	58.9
Helisoma trivolvis (Say)	3	1.3
Gyraulus parvus (Say)	24	10.6
Promenetus exacuous (Say)	6	2.7
Fossaria parva (Lea)	25	11.1
Pisidium nitidum pauperculum Sterki	34	15.0
Physa gyrina Say	1	0.4

(8) NE ¼, NE ¼ sec. 27, T. 17 S., R. 2 E.; depth 24"; 1968; no fossils.

(9) SE ¼, SE ¼ sec. 22, T. 17 S., R. 2 E.; depth 14"; 1968; 312 specimens.

Species	No. Species	Per cent Indiv.
Valvata humeralis californica Pilsbry	86	27.6
Promenetus exacuous (Say)	42	13.5
Gyraulus parvus (Say)	87	27.9
Fossaria parva (Lea)	97	31.0

HISTORY OF THE LACUSTRINE FAUNA

The species in the Manti deposit is a typical freshwater assemblage. The general environment would have been a quiet, shallow lake with a bottom that would have consisted of fine sediments, including fine sand, silt, clay, and mud. Near shore there were areas on the bottom that were probably covered with pebbles and granules. It was a lake of moderate to abundant vegetation. There were no waves to speak of and no strong currents. The assemblages indicates that the average depth of the lake was 2 m., for the Mollusca occur across the entire floor of the valley of the study area. The average pH ranged from 7 to 8 as indicated by the abundance of _Gyraulus parvus_ and _Valvata humeralis californica_. The probable limits of the fixed carbon dioxide are between 7.5 and 30.56 ppm.

Either _Gyraulus parvus_ (Say) or _Valvata humeralis californica Pilsbry_ is the most abundant in all but one of the collections. _V. humeralis californica_ is most abundant in collections 2 and 7, while _G. parvus_ is most abundant in collections 1, 3, and 5. The reason the two species vary in their abundance is that _V. humeralis californica_ can flourish at greater depth than can _G. parvus_ (Table 3).

In collection 9 the author found that _Fossaria parva_ was the most dominant, consisting of 31 percent of the species, while _G. parvus_ and _V. humeralis californica_ composed 27.9 percent and 27.6 percent respectively. This is the result of the lake's being shallower, less than 1 m., and having a higher carbon dioxide concentration than in the areas of the other collections. _F. parva_ is

Table 3. Relations of Mollusca to character of bottom, depth of water, range of pH and carbon dioxide dissolved.

Species \ Character of Bottom	Boulder	Gravel	Sand	Silt	Clay	Mud	Depth of Water meters 0–1	1–2	2–3	3–4	4–5	5–6	6+	pH range	carbon dioxide ppm.
Pisidium nitidum pauperculum	- -	- -	—	—	—	—	-	—	—	- -	- -			7.0-8.0	9.3-24.73
Valvata humeralis californica Pilsbry	- -	- -	—	- -	- -	—	—	—	—	—	—	—		.7.1 +	8 +
Gyraulus parvus (Say)	—	—	—	—	—	—	—	—	— - -	- -				7.0-8.16	8.16-30.56
Fossaria parva (Lea)	- -	—	—	—	—	—	— - -	- -						5.86-8.37	10.65-18.87
Physa gyrina Say			—	—	—	—	— - -	- -						7.1-8.37	9.5-22.75
Promenetus exacuous (Say)	—	—	—	—	—	—	-	—	—	—	—			7.0-7.64	9.3-22.5
Helisoma trivolvis				—	—	—	—	—	- -					6.6-8.37	7.5-30.56

completely absent from collection 1, probably because of a low carbon dioxide concentration, under 10.65 ppm., in that area.

Oxyloma retusa (Lea) occurs the least of any of the species. Because this is a land gastropod that lives in a moist environment, like along the swampy shores of a lake, it would be expected not to find it abundant in the lake.

AGE AND CORRELATIONS

It is difficult to determine the age of the Manti deposit because little information is available on Pleistocene molluscan assemblages of Utah. Roy (1962, p. 12) describes a Mollusca assemblage about one mile south of the area covered in this paper. The assemblage the author has reported is included in the assemblage reported by Roy. The two most abundant species in both deposits are recorded for the Pliocene. Gyraulus parvus is reported in Pliocene by Taylor (1960, p. 58). Chamberlin and Berry (1933, p. 29) report the occurence of Valvata humeralis californica for the Pliocene. Both these species as well as the other species that occur in the deposit still exist in Utah today (La Rocque, manuscript records).

Roy (1962, p. 5) reports that his Gunnison deposit in Sanpete Valley is between 5400 and 5450 feet above sea level. The area covered in this paper is approximately one mile north of Roy's Gunnison deposit. It has approximately the same molluscan assemblage, and occurs at the same elevation as the Gunnison deposit. Therefore it would seem very likely that these two are the same deposit. If this is true, and the author believes that it is, the age of the Manti deposit is also of Wisconsin age and probably of latest Wisconsin age (Roy, 1962, p. 12).

GEOMORPHOLOGY

EARTHFLOW. The lake formed as a result of a debris flow that came out of Six Mile Canyon and moved across Sanpete Valley damming up the San Pitch River. Wallace (1964), who made a study of mass movement in the area, reports that a bouldery deposit moved across the Sanpete Valley blocking the San Pitch River. The general drainage of the area was probably to the south as it is today. As a result, the water backed up behind the bouldery debris flow forming the lake to the north.

LAKE EVIDENCE. Twin Knolls and hill 5532 existed at the time of lake deposition. There is at least one terrace, possibly two, on the west side of Twin Knolls, and also there are two especially evident on the east side of hill 5532. A terrace may exist around the eastern, western, and southern sides of River Knoll.

There is no evidence for major movement in the study area after deposition of the lake sediments. Minor movement may have occurred on River Knoll since three faults with vertical displacements of one ince were observed in a road cut on the north end of the knoll.

The most important evidence for a lake are the freshwater Mollusca that were collected and discussed earlier.

It is difficult to establish a beach area for the lake. On the west side of Sanpete Valley the fossiliferous clay is at an elevation of 5430 feet above sea level. On the eastern side of the valley the fossiliferous clay is located at 5443 feet. It is rather unlikely that such a discrepancy of 13 feet should exist. On the west side of the valley what is thought to be a beach is located between 5430 and 5450. No beach could be located on the eastern limits of the fossiliferous clay. The difficulty arises from present day alluvial material covering the lake sediments. The discrepancy can be resolved easily by realizing that present day alluvium is covering much of the shores of the lake. There is more alluvial material covering the western edge than the eastern edge of the deposit because the western edge is within a mile of the front of the Gunnison Plateau, whereas the eastern side is about 2 miles from the Wasatch Plateau.

DRAINAGE. Today the area drains to the south just as it did at the time of the Manti lake deposit. It was forced to drain around the west side of the bouldery debris flow through the present day Gunnison Reservoir area. If it had not drained to the south, the bouldery deposit at Six Mile Canyon could not have caused a lake to the north. Furthermore, the Wasatch Mountains were blocking the way for drainage to the north. It drained very slowly, for the lake was filled with Mollusca that live in quiet water, well protected from waves and strong currents.

MECHANICAL ANALYSIS. Finally, a mechanical analysis was made on the eleven samples collected (Table 4). Samples 10 and 11 were omitted because of lack of fossils. Samples 1, 2, 3, 5, 7, and 9 indicate the quietness of the lake environment by the percentages of very fine sand, silt, and clay recorded. In these samples the

Table 4. MECHANICAL ANALYSIS OF SEDIMENTS. The sediments were analyzed as follows: above 4 mm. - pebble; 4-2 mm. - granule; 2-1 mm. - very coarse sand; 1-1/2 mm. - coarse sand; 1/2-1/4 mm. - medium sand; 1/4-1/8 mm. - fine sand; 1/8-1/16 mm. - very fine sand; less than 1/16 mm. - silt and clay. Weight is in grams

	Sample 1.		Sample 2.	
	Weight	per cent	Weight	per cent
above 4 mm.	0.000	0.00	0.000	0.00
4 - 2 mm.	0.503	1.01	0.000	0.00
2 - 1 mm.	1.276	2.56	0.043	0.08
1 - 1/2 mm.	1.730	3.49	0.098	0.19
1/2 - 1/4 mm.	2.090	4.20	1.074	2.16
1/4 - 1/ 8 mm.	6.162	12.38	6.940	13.90
1/8 - 1/16 mm.	19.827	39.86	28.960	58.04
less than 1/16 mm.	18.158	36.50	12.788	25.63
Total	49.746	100.00 %	49.903	100.00 %

	Sample 3.		Sample 4.	
	Weight	per cent	Weight	per cent
above 4 mm.	0.000	0.00	0.000	0.00
4 - 2 mm.	0.147	0.29	0.050	0.10
2 - 1 mm.	0.129	0.26	0.050	0.10
1 - 1/2 mm.	0.185	0.37	0.180	0.36
1/2 - 1/4 mm.	1.798	3.42	1.050	2.11
1/4 - 1/8 mm.	10.855	21.73	7.660	15.38
1/8 - 1/16 mm.	27.443	54.94	26.995	54.21
less than 1/16 mm.	9.489	18.99	13.815	27.74
Total	49.956	100.00 %	49.800	100.00 %

	Sample 5.		Sample 6.	
	Weight	per cent	Weight	per cent
above 4 mm.	0.000	0.00	0.000	0.00
4 - 2 mm.	0.000	0.00	0.000	0.00
2 - 1 mm.	0.032	0.06	0.000	0.00
1 - 1/2 mm.	0.069	0.14	0.038	0.07
1/2 - 1/4 mm.	0.690	1.40	2.900	5.83
1/4 - 1/8 mm.	9.082	18.41	13.375	26.86
1/8 - 1/16 mm.	26.168	53.04	19.619	39.38
less than 1/16 mm.	13.295	26.95	13.880	27.86
Total	49.336	100.00 %	49.813	100.00 %

	Sample 7.		Sample 8.	
	Weight	per cent	Weight	per cent
above 4 mm.	0.000	0.00	0.000	0.00
4 - 2 mm.	0.000	0.00	0.000	0.00
2 - 1 mm.	0.000	0.00	0.000	0.00
1 - 1/2 mm.	0.000	0.00	0.051	0.10
1/2 - 1/4 mm.	0.022	0.04	0.160	0.32
1/4 - 1/8 mm.	10.835	21.32	2.943	5.91
1/8 - 1/16 mm.	31.494	61.95	26.694	53.55
less than 1/16 mm.	8.485	16.69	19.993	40.12
Total	50.836	100.00 %	49.841	100.00 %

	Sample 9.		Sample 10.	
	Weight	per cent	Weight	percent
above 4 mm.	0.000	0.00	0.898	1.82
4 - 2 mm.	0.000	0.00	1.338	2.69
2 - 1 mm.	0.014	0.02	0.797	1.60
1 - 1/2 mm.	0.070	0.15	0.608	1.23
1/2 - 1/4 mm.	0.279	0.56	2.538	5.13
1/4 - 1/8 mm.	2.196	4.39	8.578	17.31
1/8 - 1/16 mm.	26.930	53.95	27.358	55.19
less than 1/16 mm.	20.431	40.93	7.447	15.03
Total	49.920	100.00 %	49.562	100.00 %

	Sample 11.	
	Weight	per cent
above 4 mm.	1.632	3.27
4 - 2 mm.	7.164	14.36
2 - 1 mm.	6.178	12.39
1 - 1/2 mm.	6.086	12.20
1/2 - 1/4 mm.	5.683	11.39
1/4 - 1/8 mm.	7.257	14.55
1/8 - 1/16 mm.	5.847	11.72
less than 1/16 mm.	10.034	20.12
Total	49.881	100.00 %

lowest percentage of very fine sand, silt, and clay is in sample 3 where it makes up 73.93% of the sample. In sample 2 the material less than 1/8 mm. made up 83.65% of the sample..

Samples 4, 6, and 11 came from areas that were thought to be beach areas. Some fossils hash was found in all three samples but nothing that could be identified. Some ostrcods were found in sample 6 which would indicate a freshwater environment.

Sample 10 is possibly from either a sand bar or a spit that existed in the lake. It came from an elevation of about 5445, which is within the limits of the lake; 17.30% is fine sand, 55.19% is very fine sand, and 15.02% is silt and clay.

Sample 8 is from the nose of the alluvial fan coming out of Maple Canyon South. 93.66% of the material is less than 1/8 mm.

SUMMARY

A lake, which was a quiet, shallow lake with a bottom consisting of fine sand, silt, clay, and mud, as determined by the environments of the molluscan fauna as well as by the mechanical analysis of the sediments, was formed as a result of a large bouldery debris flow that came out of Six Mile Canyon and dammed the San Pitch River. A lake formed behing the bouldery dam, thus depositing "The Gunnison Reservoir Deposit" (Roy, 1962) and the Manti deposit of this report. The similarities of these deposits, similar molluscan fauna and similar elevation, indicate that they are of the same origin. Thus the name Lake Sterling is proposed for this lake.

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