STRATIGRAPHIC SUMMARY OF QUATERNARY BONNEVILLE BASIN MOLLUSCA

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ABSTRACT

This is the first stratigraphic summary of the Bonneville Basin Quaternary molluscan fauna since 1884. The development of Quaternary stratigraphy in the Basin is briefly reviewed, and work in progress is noted. Stratigraphic and systematic catalogs are presented. Related deposits in the Snake River drainage are briefly mentioned. No attempt is made to include a discussion of problems relating to relative or absolute chronology or of correlation with either montane or continental glaciation. The references cited comprise a selected bibliography on Basin Quaternary research.

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INTRODUCTION

The drainage of the Bonneville Basin covers an area of about 55,000 square miles. Four-fifths of this area is located in Utah, with slightly more than 10,000 square miles in the contiguous states of Nevada, Idaho, and Wyoming. The Basin is approximately delimited by the geographical coordinates of 110° - 115° West Longitude and 37° - 43° North Latitude. Physiographically most of the area falls within the Great Basin Division of the Basin and Range Province, with relatively small but important portions along the eastern margin belonging to the Rocky Mountain and Colorado Plateaus Province (Fenneman, 1931).

The study of the Quaternary history of the Bonneville Basin may be divided into two periods. Beginning in 1849 with the recognition of the existence of an ancient lake in the Basin by Howard Stansbury, the first period reached its zenith with the publication of G. K. Gilbert's monograph on Lake Bonneville in 1890. For over fifty years "Lake Bonneville" was the unchallenged classic and basic reference work. The second period, beginning about 1945 when Ernst Antevs made the first significant modification of the Gilbertian explanation of Lake Bonneville history, owes its chief stimulus to the critical post-World War II need for information on the underground water resources of the Basin. About 80 percent of the papers dealing with the Basin Quaternary have been published during this period.

Gilbert was the first to recognize the value of studies of the Basin molluscan fauna in deciphering Quaternary climatic changes. At his instigation R. E. Call was appointed to investigate and report on the Quaternary mollusks of the entire Great Basin. The present paper is the first to summarize the stratigraphic distribution of the Bonneville Basin fauna in light of the work accomplished since Call's report of 1884.

ACKNOWLEDGMENTS

In a very real sense whatever merit this paper may have is due to all those who have labored with the problem of the Bonneville Basin Quaternary. My chief capacity has been that of brain-picker. Without exception, all those to whom I have turned for assistance of one sort or another have wholeheartedly responded. In alphabetical order these persons include: E. Antevs, R. C. Bright (U. Minnesota), A. J. Eardley (U. Utah), J. H. Feth (USGS); H. D. Goode (USGS); C. B. Hunt (USGS); D. J. Jones (U. Utah); R. E. Marsell (U. Utah); R. Morrison (USGS); W. L. Stokes (U. Utah); D. W. Taylor (USGS); and J. S. Williams (Utah State U.).

Two of my colleagues at the Museum, Joanne L. Evenson and E. S. Richardson, Jr., have given the manuscript the benefit of their criticism, resulting in substantial improvement in both organization and content. For remaining errors of fact and ineptitude of expression I alone must be held responsible. To my wife, Lottie, I owe much for assistance with several revisions and the typing of the final draft of the manuscript.

DEVELOPMENT OF QUATERNARY STRATIGRAPHY IN THE BONNEVILLE BASIN

Gilbertian Period

The chief deterrent to the study of the Quaternary of the Basin has been the lack of extensive natural surface exposures. Investigations at a few favorable localities led Gilbert (1874, 1890) to propose a sequence of deposits which he interpreted as indicating two lacustrine periods. Gilbert's stratigraphy, which was followed by almost every writer up to 1953, is summarized in Table 1. Also indicated are correlations with strand lines, lake history, and time units as used during this period.

Gilbert took pains to point out that his scheme was probably an over-simplification. He fully realized that both Lake Bonneville and the unnamed pre-Bonneville lake together did not represent the whole of the Quaternary history of the Basin.

Table 1. Summary of Gilbertian Stratigraphy

Stratigraphy	Strand Line	Lake	Time Unit
Post-Bonneville deposits	no lake	----	Post-Bonneville (Post-Provo)
none given	Stansbury	Stansbury stage	
White Marl	Provo Bonneville	Bonneville	Bonneville
unnamed gravel	no lake	----	
Yellow Clay	Intermediate	Pre-Bonneville	Pre-Bonneville
not named	none	other lakes ?	

Post-Gilbertian Period

To overcome the lack fo surface exposures attention was directed to well logs in an effort to get a detailed history of Lake Bonneville as a complete Quaternary history of the Basin. Over the years a considerable number of drillings were made in the Basin, primarily for water, but some for gas and oil. Unfortunately, these proved to be of slight assistance in the study of the Quaternary. Drilling tended to be concentrated in the extreme eastern margin of the Basin near the mountain front. Here nearshore deposits reach their maximum thickness, but are discontinuous, representing only the higher lake levels. The deepest log known, that of the Guffey and Galey well near Farmington, Davis Co., Utah, penetrated about 2000 feet of Quaternary sediments without reaching bedrock (Boutwell, 1904). Also, drillers' terminology and the drilling technique itself are apt to be unsuitable for stratigraphic work.

An extensive test of the value of drillers' logs was made by Feth in 1953. Study of a peg model of about 300 logs from the Ogden Valley area revealed that "... it was impossible to correlate individual beds across significant distances in an east to west direction underground, except in a few places. It is possible, however, to make reasonable correlations of strata, or at least of zones, in directions approximately parallel to the mountain front ..."

More recently attention has been turned to cores to supply the missing chapters in the Basin Quaternary story. In 1951 and 1952 a series of relatively shallow cores were obtained from beneath Great Salt Lake, none of which penetrated beyond the Stansbury (post-Provo) stage sediments (Schreiber, 1958, 1961).

The results of a study of the first deep core made in the Basin appeared in 1960. Eardley and Gvosdetsky believe that a 650 foot core from near the southeast margin of Great Salt Lake penetrated sediments corresponding to the second interglacial (Aftonian) stage. Although it was not possible to correlate any portion of the "Saltair" core with either Gilbertian or later stratigraphic units, it has clearly demonstrated the complex Quaternary history of the Basin. A tentative correlation with deep-sea core chronology of Emiliani (1958) was offered. It is hoped that subsequent cores (a second is now under study) will resolve many of the correlation problems.

Modern Bonneville Basin Stratigraphy

Present Basin Quaternary stratigraphy is based on exposures due to the operation of sand and gravel pits, reclamation, and other construction projects. Much more information has thus been available than prior workers had at their disposal.

Study of such exposures in northern Utah Valley in the late 40's and early 50's as part of a continuing program of investigations by the U. S. Geological Survey resulted in the establishment (Hunt, Varnes, and Thomas, 1953) of a stratigraphic sequence which has been generally adopted for other areas by most subsequent workers. This Utah Valley sequence is summarized in Table 2. An additional pre-Alpine unit, the Green Clay Series, has been proposed by Marsell and Jones (1955) as a result of studies in Jordan (Salt Lake) Valley. Studies in the Promontory Range at the north end of Great Salt Lake has led to the discovery of what is said in a preliminary report (Goode, 1960) to be the most complete sequence of Lake Bonneville deposits to be found.

A concluding report on southern Utah Valley, as well as reports on several other areas in the Basin, are in various stages of completion (C. B. Hunt, personal communication, June 7, 1960). These are referred to in appropriate places in the stratigraphic catalog section of the present paper. It is not known at this time whether any of these reports will lead to further modifications in stratigraphic nomenclature.

Studies in the two-thirds of the Basin not occupied by the waters of Lake Bonneville have been scant. A notable exception is the work on Bear Lake Valley by Williams, Willard, and Parker (1962), in which the Bear Lake formation is named and described.

Despite the considerable progress made in the study of the Bonneville Basin Quaternary in the past decade, much remains to be accomplished. Many new techniques and disciplines, such as C-14 dating, fossil pollen analyses, paleosols, have not yet been, or are only beginning to be, applied to the problem. There are many problems relating to absolute and relative dating of events; of correlation of lake sediments to the abandoned strand lines; of correlation to the montane glacial stages thought to be concurrent with the pluvial phenomena; of correlation to the standard Pleistocene section as developed in the eastern part of the continent. The next decade may well see equalled or exceeded all that has gone before.

Should an attempt be made at this time to summarize the Basin Quaternary molluscan fauna? Somewhere H. E. Gregory has written that "Geology has to choose between the rashness of using imperfect evidence or the sterility of uncorrelated, unexplained facts." It is a choice and a challenge I could not resist. If the scaffold erected here proves of some use in the construction of the permanent edifice, I will feel amply rewarded for the labor.

STRATIGRAPHIC CATALOG

This section includes all published reports of mollusks which can be assigned to a specific stratigraphic unit, whether of known or uncertain stratigraphic position. Many of the molluscan records lack context *, and the locality data are so inexact as to make it impossible to recover this vital information now. For this reason some papers cited in my previous report (Roscoe, 1961) are not included in the present one. It should be stressed that the collecting of masses of material by persons with no training in stratigraphic

* A term borrowed from archaeology. An artifact is said to have context when its position, both horizontally and vertically, is known. A specimen lacking this information is "out of context," and its scientific value materially decreased. It is possible for a specimen to have precise horizontal context, but lack vertical context. The converse is rarely, if ever, encountered in paleontological work.

Table 2. Summary of Northern Utah Valley Bonneville Stratigraphy. (From Hunt, Varnes, and Thomas, 1953)

NOMENCLATURE			SEDIMENTS
Pleistocene?		Post-Provo deposits	Mostly uncemented fanglomerate, alluvial gravel or alluvial sand; some eolian (?) silt and thin lake deposits. Maximum thickness about 50 feet.
		Unconformity	
Pleistocene	Lake Bonneville Group	Provo formation	Extensive gravel member, as much as 50 feet thick, occurs in deltas and embankments; a thinner and less extensive sand member occurs as facies in the deltas and forms bars in front of them; a silt member and a clay member comprise the deep water deposits, but they generally are less than 20 feet thick.
		Unconformity	
		Bonneville fm.	Gravel and sand, restricted to embankment deposits
		Unconformity	
		Alpine formation	Mostly silt and clay; some gravel and sand near canyon mouths. Maximum thickness about 25 feet.
		Unconformity	
Pre-Lake Bonneville deposits (glacial, lacustrine, and fluvial).			Includes at least one moraine of pre-Lake Bonneville age. Includes deposits of several lakes that, in size and duration apparently were comparable to Lake Bonneville; these lake deposits are separated by fanglomerate and other fluviatile deposits. Total thickness 680 feet or more.
		Unconformity	
Pliocene?	Salt Lake formation		Water-laid pyroclastics, fanglomerate.

techniques (and this includes the majority of biologists) will be of little aid. Where deposits are found, competent geological assistance should be sought. It has been my experience that such assistance is readily given.

The organization of this section of the paper has proved to be a difficult problem. Because of lack of exact correlation of Gilbertian units with modern stratigraphic terminology, a straightforward bottom-to-top presentation is unfeasible at present. Reference to the table of contents will show the relationship of any particular unit to the over-all organization of this section of the paper.

Deposits Within the Lake Bonneville Area

The following section includes a discussion of all deposits from within the one-third of the Basin covered by the waters of Lake Bonneville, whether laid down in that body of water or not. The section is thus divided into (1) pre-Lake Bonneville deposits, (2) Lake Bonneville deposits proper, and (3) post-Lake Bonneville (post-Provo) deposits.

Pre-Lake Bonneville Deposits

The term "pre-Lake Bonneville" is here used in its modern, not Gilbertian, sense. The only record definitely known from this time period has been obtained from a 650 foot coring made near the edge of Great Salt Lake and reported upon by Eardley and Gvosdetsky (1960). Although not penetrating to the base of the Quaternary, this core has revealed the existence, since the second (Kansan) glacial epoch, of several large open water stages of lakes of a size comparable to that of the Provo stage of Lake Bonneville.

Unfortunately, it was found impossible to correlate any portion of the Saltair core with either the various strand lines named and described by Gilbert, or with the stratigraphy developed for Utah and Jordan valleys (discussed in a subsequent section). A summary of the mollusks reported from the Saltair core, together with the tentative correlation with the standard Pleistocene stages is given in Table 3. It will be noted that only five taxa are restricted to any given stage, and all of these are known to range throughout the Pleistocene, and hence cannot be said to be index fossils.

A second deep core has subsequently been obtained (Eardley, oral communication, April, 1961) and will be reported upon in due course. Eardley says that the molluscan fauna from this second core is negligible.

Lake Bonneville Deposits

At the present time it seems prudent to present first, and separately, a discussion of Gilbertian stratigraphic units. Assignment of these units to their proper place in the modern Bonneville sequence is still under investigation by geologists (Varnes and van Horn, 1961). Aside from this segment, the presentation proceeds from the base of the stratigraphic column to the top. All units are noted, although mollusks are not known to occur in some of them and specific determinations are lacking for others. Several impending reports, mentioned in appropriate places, promise to fill in some of the gaps.

Gilbertian Units:

Yellow Clay. No mollusks have been specifically reported from Gilbert's Yellow Clay. Varnes and van Horn (1961) assign a portion of the Yellow Clay to the Alpine of the Utah Valley sequence. The Alpine is known to be fossiliferous (Feth, unpublished MS; Goode, 1961), but no identified material has yet been reported from the formation. Varnes and van Horn (1961: 99) state that the Alpine or Yellow Clay comprises more than three-fourths of the Lake Bonneville sediments.

White Marl and Equivalents. The Upper Bonneville Beds of Call (1884) and the Bonneville Marl of Berry and Crawford (1932) are here taken as equivalent to Gilbert's White Marl. Varnes and van Horn (1961) indicate that the White Marl is partly to be assigned to the Alpine formation, partly to the Bonneville-Provo formation. No faunal comparisons are possible at

Table 3. Mollusks reported from the Saltair Core (Data from Eardley and Gvosdetsky, 1960)

MOLLUSK[1]	STAGE[2] Kansan	Yarmouth	Illinoian	Sangamon	Wisconsinan[3] (Würm 1)	(Laufen)
(5) Anodonta sp.	X*					
(7) Pisidium sp.	X	X				
(10) Sphaerium striatinum					X*	
(11) Sphaerium sp.				X	X	
(17) Physa sp.	X				X	
(20) Stagnicola caperata	X	X		X		
(22) Stagnicola cockerelli	X*					
(23) Fossaria dalli					X*	
(20) Stagnicola palustris		X			X	
(34) Stagnicola sp.	X	X	X			X
(35) Armiger crista				X*		
(30) Gyraulus circumstriatus	X	X			X	X
(40) Gyraulus parvus		X	X	X	X	X
(42) Gyraulus sp.		X	X	X	X	X
(45) Helisoma sp.	X	X			X	X
(47) Promenetus exacuous				X*		
(48) Promenetus umbilicatellus	X*					
(49) Ferrissia sp.			X*			
(55) Amnicola sp.		X			X	
(62) Valvata humeralis	X	X		X	X	X
(64) Valvata utahensis		X			X	X
(79) Succinea sp.				X		
Total	10	11	3	7	12	7
Peculiar (asterisk)	3	0	1	3	2	0

1. The nomenclature is that of Eardley and Gvosdetsky. Numbers in parentheses follow my previous list (1961).
2. No mollusks were reported from either the Aftonian or Würm II.
3. I retain the terminology of Eardley and Gvosdetsky in parentheses.

present. The Bonneville formation, so far as known, is an unfossiliferous near-shore deposit, while no specific identifications have been reported from the Alpine. About one-third of the mollusks known from the White Marl are also known from the Provo formation. These are indicated by an asterisk. The following 16 species have been reported from the White Marl or its equivalents. Numbers in parentheses are those used in my 1961 checklist.

(9) Sphaerium pilsbryanum Sterki. Berry and Crawford (1932).

*(13) Physa ampullacea (Gould. Berry

and Crawford (1932).

(14) Physa gyrina Say. Call (1884).

(19) Lymnaea bonnevillensis (Call). Call (1884); Hassler and Crawford (1938); Ives (1946).

(26) Lymnaea kingii (Meek). Berry and Crawford (1932).

(29) Lymnaea palustris (Müller). Call (1884); Berry and Crawford (1932).

(31) Lymnaea stagnalis appressa (Say). Baker (1911).

*(33) Lymnaea utahensis (Call). Berry and Crawford (1932).

(41) Gyraulus vermicularis (Gould). Berry and Crawford (1932).

(44) Helisoma trivolvis (Say). Call (1884); Berry and Crawford (1932).

(50) Amnicola cincinnatiensis (Anthony). Call (1884); Hasler and Crawford (1938).

(53) Amnicola longinqua Gould. Ives (1946, 1951).

(54) Amnicola porata (Say). Call (1884).

*(57) Fluminicola fusca (Haldeman). Call (1884); Berry and Crawford (1932).

(63) Valvata humeralis californica Pilsbry. Berry and Crawford (1932).

*(64) Valvata utahensis (Call). Berry and Crawford (1932).

Bonneville Beds. This designation has been used by several authors, presumably for cases in which it was not known whether the material came from the Yellow Clay (Lower Bonneville Beds) or White Marl (Upper Bonneville Beds). Comparisons with the Utah valley sequence are of slight value at present, since the faunas of all units are not known. Four species (indicated by an asterisk) are not known from any of the Utah valley formations, although this absence may be nomenclatural rather than biological. The term "Bonneville Beds" may be taken as equivalent, in whole or part, to the Bonneville Group of modern terminology.

(19) Lymnaea bonnevillensis (Call). Call (1886); Baker (1911).

*(24) Lymnaea desidiosa Say. (Gilbert, 1875).

(31) Lymnaea stagnalis appressa Say. Hannibal (1912).

*(32) Lymnaea sumassi Baird. Call (1884).

(50) Amnicola cincinnatiensis (Anthony). Gilbert (1875); Hannibal (1912).

(57) Fluminicola fusca (Haldeman). Hannibal (1912).

*(59) Pomatiopsis lustrica Say. Gilbert (1875).

*(78) Succinea lineata Binney. Gilbert (1875).

Bonneville Terrace. Although not a stratigraphic unit, it should be noted that two genera, Lymnaea and Planorbis (=Helisoma), were reported by Crawford and Chroney (1944) from travertine deposits of the "uppermost"(Bonneville) terrace. So far as known, Lake Bonneville reached this level only once in its history; hence this travertine is presumably referable to the Bonneville formation. If this assumption is correct, these two generic records represent the only known mollusks recorded from the Bonneville formation.

Modern Stratigraphic Units.

Modern stratigraphic terminology of the Bonneville deposits began with investigations by the U. S. Geological Survey on the Quaternary System of the Basin, at first in Utah Valley and later studies on other areas (see map in Hunt et al., 1953: 3). In the following discussion I have attempted to summarize the progress of this work. Such molluscan finds as have been reported are noted, as well as an indication of those areas expected to yield important information in the near future. The Survey has greatly simplified the task of keeping abreast of its progress by the inauguration in 1960 of annual summaries of research work (see Prof. Papers 400-a, b, 1960; 424 a-d, 1961).

Green Clay Series. Established as the basal Pleistocene formation in the lower Jordan (Salt Lake) Valley by Jones and Marsell (1955), surface exposures of this formation are rare. Two facies are recognized, a near-shore conglomerate and an off-shore claystone and siltstone. The stratigraphy of Jordan Valley and its Pleistocene history are discussed in two joint papers by Jones and Marsell in 1955. The Utah Geological and Mineralogical Survey has in preparation a volume dealing with this area in its Geological Atlas series. To date only the geological map is available.

Molluscan fauna. Molluscan records referable to definite stratigraphic units from Jordan Valley are surprisingly few. None have been reported from the Green Clay series. Ostracodes have been found in the off-shore facies.

Alpine Formation. Originally described from near-shore deposits at Alpine, Utah County, in Utah Valley, by Hunt et al. (1953), this formation has subsequently been found in Jordan Valley by Jones and Marsell (1955) where it unconformably overlies the Green Clay series. It has been recognized in Ogden Valley by J. H. Feth of the U. S. Geological Survey, whose report is undergoing editorial revision at this writing (H. D. Goode, personal communication, January, 1962), and in the East Tintic area, where it is reported to contain abundant remains of unspecified gastropods and ostracodes (Goode, 1961). The Alpine is definitely associated with Gilbert's Intermediate Terrace (5050 ft. elev.), which was formed by Gilbert's "pre-Bonneville" high water stage. Varnes and van Horn (1961) correlate the whole of Gilbert's Yellow Clay and a portion of his White Marl with the Alpine. On the basis of prevailing texture the formation is divided into three members bearing lithologic names, although none are homogeneous units.

Molluscan fauna. No fossils were recovered from the Alpine in Utah Valley (Hunt et al., 1953), but the formation is known to be fossiliferous in Ogden Valley (J. H. Feth, personal communication, 1955) and the Tintic area (Goode, 1961). It is anticipated that Feth's forthcoming report will include the first identifications from the formation.

Bonneville Formation. Described by Hunt, Varnes, and Thomas (1955) from Utah Valley, this formation is represented only by a thin, discontinuous beach deposit of the highest (Bonneville) lake stage of Gilbert. The formation has not been recognized in Jordan Valley (Jones and Marsell, 1953). Goode (1961) reports the formation as sparse in the East Tintic area. Varnes and van Horn (1961) correlate a portion of Gilbert's White Marl with the Bonneville formation.

Molluscan fauna. It is impossible at present to say which of the records from the White Marl properly belong to the Bonneville Formation. The genera *Lymnaea* and *Planorbis* (=*Helisoma*) were reported by Crawford and Chroney (1944) from travertine deposits of the "uppermost" [Bonneville] terrace, presumably equivalent to this formation.

Provo Formation. Described by Hunt, Varnes, and Thomas (1953), the Provo is the most extensive formation known from the Basin. It is divided into four members distinguished by prevailing lithologies. In both Utah and Jordan valleys (Bissell, 1952; Jones and Marsell, 1955) the dual nature of the Provo shore deposits has been recognized. Many exposures show two nearly identical deposits associated with the two Provo shore lines (4800 and 4700 ft. elev.), with a well-developed soil profile between. Goode (1961) reports deposits in the East Tintic area tentatively referred to this formation. The sequence in Utah Valley, as outlined by Hunt, Varnes, and Thomas (1953) is as follows:

Gravel member. Occurs principally as delta deposits. Gastropods are plentiful in this member at Point of Mountain (near Utah-Salt Lake County line), while elsewhere few shells have been observed.

Sand member. Gastropods are abundant in this member where it grades into the finer-grained lake bottom sediments.

Silt member. Gastropods and ostracodes are abundant in this member in front of deltas, where in places they form almost a coquina.

Clay member. Represents deposits of the interior of the lake. Ostracodes seem to be

Table 4. Summary of Provo Formation Molluscan Fauna.
(Data from Hunt, Varnes, and Thomas, 1953).

Gravel	Sand	Silt	Clay
Unidentified gastropods	Unidentified gastropods		
			(7) Pisidium sp.
			(13) Physa ampullacea
			(16) Physa lordi
		(33) Lymnaea utahensis	
		(37) Carinifex newberryi	(37) Carinifex newberryi
			(46) Pompholopsis whitei
		(53) Amnicola longinqua	
			(55) Amnicola sp.
		(57) Fluminicola fusca	(57) Fluminicola fusca
	(64) Valvata utahensis	(64) Valvata utahensis	(64) Valvata utahensis
		(68) Oreohelix strigosa depressa	
		(77) Succinea avara	

more abundant and gastropods fewer in the clay than in the silt member. Commonly there is a concentration of shells about a foot above the base of the clay. Yen (in Hunt et al., 1953) believes that the environmental conditions were much the same as they are now in Utah Lake, suggesting a habitat of rich aquatic shore vegetation, possibly a somewhat marshy area.

Molluscan fauna. All of the published records specifically referable to the Provo formation are contained in the paper by Hunt, Varnes, and Thomas (1953). Table 4 summarizes this fauna.

Post-Bonneville (Post-Provo) Deposits

Which of these two terms is the correct one hinges upon a sharper delineation of the term "Lake Bonneville." It is clear that both Gilbert (1890) and Call (1884) considered the Stansbury and all later stages as post-Bonneville, thus delimiting Lake Bonneville at the Provo stage. Some later writers have used the term "Lake Bonneville" to apply to all but the historical fluctuations of the lake. In recent years the term "post-Provo" has come into wide usage in the same sense as Gilbert's "post-Bonneville." A complication arises from the fact that it has been demonstrated that the Provo shore line was reoccupied a second time. The term "post-Provo" is here taken to mean post-Provo II.

A satisfactory post-Provo stratigraphic nomenclature is yet to be devised. In all probability the period of time represented falls into the Deglacial and Neothermal of Antevs (1948). Ives (1951) has proposed several lake stages in this interval without corresponding stratigraphic terminology. Generally, three broad categories of sediments are recognized (Hunt et al., 1953; Jones and Marsell, 1955): (1) Alluvial deposits, (2) Eolian ? silt, and (3) lake deposits.

During the summers of 1951 and 1952 six coring stations were occupied by the University of Utah investigators in the southern part of Great Salt Lake. From these stations a total of 111 feet of relatively undisturbed sediments were recovered. The deepest core penetrated 43 feet 5 inches beneath the bottom of Great Salt Lake. The stratigraphy of these cores was reported by Schreiber (1958, published abstract, 1961) as a series of "lithic types" summarized in Table 5.

Table 5. Summary of Cores from beneath Great Salt Lake
(Data from Schreiber, 1961)

Lithic Type	Environmental Characteristics	Fauna
I	Typical of a very saline environment such as the present Great Salt Lake. High carbonate content.	Abundant fecal pellets, brine shrimp egg capsules.
II	Typical of deeper core intervals. Deposited in a fresh-water to slightly brackish lake. Carbonate percentages about 1/3 those of Type I.	Abundant ostracode fauna and lesser numbers of gastropods. Chara oogonia.
III	Observed in bottom of core 4 only. Believed deposited in a low level lake stage of 2 to 3 percent salinity.	None.

Schreiber believes that the sediments of Type II were deposited during the Stansbury stage, and he reports C-14 dating of this stage as from 23,000 to 13,500 years B. P. He also believes the Type III sediments were probably deposited during the pre-Stansbury interpluvial which was a low lake stage possibly near the Gilbert level. All of Schreiber's material, therefore, belongs to the post-Provo period.

Molluscan fauna. Undoubtedly much of the earlier molluscan records which lack context belong to the post-Provo sequence. There is no reason to doubt that the post-Provo fauna will ultimately prove to be very similar to the "Recent" fauna. In the meantime only the following can be assigned to this time interval.

(3) Anodonta nuttalliana Lea. "Post-Bonneville," Call (1884).

(8) Sphaerium dentatum (Haldeman). "Post-Bonneville," Call (1884).

(15) Physa heterostropha (Say). "Semi-fossil," Call (1884).

(33) Lymnaea stagnalis (L.) "Semi-fossil," Call (1884).

(44) Helisoma trivolvis (Say). "Post-Bonneville," Call (1884).

Stratigraphic Units of Uncertain Position

Little Valley, Promontory Mountains. Excavations in Little Valley at the south end of the Promontory Range, Box Elder County, to provide fill for a railroad causeway across Great Salt Lake revealed what is believed to be the most complete exposure of Lake Bonneville deposits to be discovered to date. A mimeographed report on this area was prepared by H. D. Goode for the Sixth Annual Field Trip of the Rocky Mountain Section, Friends of the Pleistocene, September 1960. Subsequently a brief account, without diagrams, was published by Goode and Eardley (1960). The section contains "a pink marker bed, three or more buried soils, and two or three ash beds, one of which may be equivalent to the Pearlette ash (of the mid-continent region), [which] render the section extremely attractive for deciphering of Quaternary chronology in the eastern Great Basin." One of the ash deposits is said to be very similar to the ash found in the Saltair core at a depth of 550 feet. The mollusks from the Little Valley deposits have not yet been reported upon, but are in the hands of D. W. Taylor (H. D. Goode, personal communication, March 1961).

San Pete Valley. The stratigraphy and contained molluscan faunas from the Gunnison Reservoir deposit, Sanpete County (1.75 miles west of Sterling) is discussed by Roy (1962). The age of these deposits is not known, and at present cannot be correlated with the Utah Valley sequence. Roy assumes the deposit to be of Wisconsin age, probably of latest Wisconsin. However, he states (p. 12) that "Because of the similarity of the Gunnison Reservoir assemblage to that collected at a depth of 271 feet in the Great Salt Lake (Saltair) core, it may be possible to consider these two assemblages as of the same age." This would contradict his assignment of these deposits to the Wisconsin since Eardley and Gvosdetsky (1960) correlate this depth with the Sangamon Interglacial. The mollusks reported from the Gunnison deposits are:

- Pisidium nitidum pauperculum Sterki
- Sphaerium sp.
- Valvata humeralis californica Pilsbry
- Gyraulus parvus (Say)
- Armiger crista (L.)
- Fossaria parva (Lea)
- Physa gyrina Say
- Promenetus exacuous (Say)
- Stagnicola palustris (Müller)
- Ferrissia parallela (Haldeman)
- Helisoma trivolvis (Say)
- Succinea avara Say
- Oxyloma retusa (Lea)
- Vertigo ovata Say
- Discus cronkhitei (Pilsbry)
- Retinella binneyana occidentalis H. B. Baker
- Vallonia albula Sterki

The mollusks occur at irregular intervals and in unequal distribution throughout the deposit. They occur in clay units in the lower two-thirds of the deposit and in a sand unit in the upper third. No mollusks were found in any of the marl units. This material is deposited in the collections of the Geology Department, Ohio State University.

Deposits Outside the Lake Bonneville Area: Bear Lake Deposits

Only one other Pleistocene lake is known in the two-thirds of the Basin lying outside of the area covered by the maximum state of Lake Bonneville. For many years the peculiarly darkened shells of several species of mollusks found in great abundance on the beaches of Bear Lake (northeastern Utah and southeastern Idaho) have attracted attention and speculation as to their age. A fairly detailed history of this region is now available (Williams, Willard, and Parker, 1962). Three high level stages are described and named. Evidence is presented to show that they were produced by physical rather than climatic causes. A new formation, the Bear Lake, is named and described. C-14 dating indicates that the mollusks were killed in great numbers about 8,000 years B. P. and the authors believe that this time closely corresponds to the period of high-level stages of the lake. The "great dying" of the mollusk population appears to have taken place at the rapid shrinkage of the lake, shortly after its greatest expansion. This date would seem to place the stages of Bear Lake discussed by Williams and coworkers in the post-Provo portion of the Bonneville sequence. Shells from a depth of 92-95 feet in a test hole in the Bear Lake sediments gave a C-14 date of 27,400 ± 2,500 years. Further study is necessary before correlation of the Bear Lake history and deposits can be made with those of Lake Bonneville. Bear Lake is unusual today in that it represents practically an aquatic desert.

Molluscan fauna. Over the years a number of forms have been recorded from the Bear Lake region as "fossil" because of their peculiar bluish coloration. The following is a summary of this material.

(2) Anodonta californiensis Lea. Henderson 1931b: 109-113.
(3) Anodonta nuttalliana Lea. Chamberlin and Jones 1929: 23, 26.
(4) Anodonta oregonensis Lea. Chamberlin and Jones 1929: 24-25.

(9) Sphaerium pilsbryanum Sterki. Sterki 1909: 141; Chamberlin and Jones 1929: 32; Henderson 1931b: 109-113.

(13) Physa ampullacea Gould. Henderson and Daniels 1917: 58; Henderson 1931b: 109-113.

(29) Lymnaea palustris (Müller). Henderson 1931b: 109-113.

(30) Lymnaea proxima Lea. Henderson and Daniels 1917: 58.

(33) Lymnaea utahensis (Call). Sterki 1909: 142; Henderson 1924: 173; Chamberlin and Jones 1929: 143-144; Henderson 1931a: 77-79; 1931b: 109-113.

(36) Carinifex atopus Chamberlin and Jones. Chamberlin and Jones 1929: 156-157; Henderson 1931a: 77-79.

(37) Carinifex newberryi (Lea). Chamberlin and Jones 1929: 155-156; Henderson 1931a: 77-79; 1931b: 109-113.

(40) Gyraulus parvus (Say). Henderson and Daniels 1917: 50.

(41) Gyraulus vermicularis Gould. Henderson 1931b: 109-113.

(44) Helisoma trivolvis (Say). Henderson 1931b: 109-113.

(47) Promenetus exacuous (Say). Henderson 1931b: 109-113.

(53) Amnicola longinqua Gould. Henderson 1931b: 109-113.

(57) Fluminicola fusca (Haldeman). Sterki 1909: 142; Henderson 1931b: 109-113.

(63) Valvata humeralis californica Pilsbry. Henderson 1931b: 109-113.

(64) Valvata utahensis Call. Henderson 1931b: 109-113.

(73) Discus cronkhitei anthonyi Pilsbry. Henderson and Daniels 1917: 58; Henderson 1931b: 109-113.

(76) Vertigo ovata (Say). Henderson and Daniels 1917: 58.

(79) Succinea sp. Henderson 1931b: 109-113.

Related Deposits in the Snake River Drainage

During the Pleistocene the Bonneville Basin was an appendage to the Snake River drainage. The point of overflow, Red Rock Pass, was early detected by Gilbert (1874; 1890). Excellent photographs of this area are available in Williams (1958). A series of studies now under way by the U. S. Geological Survey in southern Idaho has a direct bearing on the Bonneville problem.

American Falls Area

Erosional and depositional features produced by the Bonneville overflow are discussed in short papers by Malde (1960) and Trimble and Carr (1961a). A detailed report is available in Trimble and Carr (1961b). Something of the magnitude reached by this Bonneville river can be realized by the fact that boulders up to 8 feet in diameter were found in a delta deposit near Pocatello, Idaho. According to Trimble and Carr, current velocity of between 16 and 48 miles per hour is indicated. "These are very broad and approximate limits," these authors state, "but when this general order of magnitude is compared with a median velocity of 3.54 miles per hour for the Mississippi River during one of its greatest floods, and with a maximum recorded velocity of about 16 miles per hour for any natural stream, it is evident that the stream responsible for the Michaud gravel attained abnormal size and velocity, at least temporarily." (Trimble and Carr, 1961b). These authors also include a list of the mollusks recovered from the American Falls deposits. C-14 dating indicates that the Michaud gravel was deposited about 30,000 to 40,000 years B. P.

Cleveland Area

Lake beds in the Cleveland area (Gentile and Mound Valleys) of southeastern Idaho were recognized as early as 1879 by Peale. Some authors have thought that they represent deposits in an arm of Lake Bonneville.

In a M. S. thesis Bright (1960) interprets these deposits to represent a Pleistocene lake, essentially contemporaneous with Lake Bonneville, which was formed as a result of damming of basaltic flows and of diversion of the Bear River into the newly created depression. According to Bright this lake, named Lake Thatcher, rose to an elevation of 5,484 feet (some 350 feet above the maximum level of Lake Bonneville), then spilled over into the Bonneville system. He believes that this spillover could have accounted for the rise and overflow of Lake Bonneville through Red Rock Pass. Two strand lines and associated deposits are named and described, both of which contain mollusks. A preliminary faunal list is given by Bright based on material identified by D. W. Taylor. Taylor has tentatively suggested that the dissimilarity of the Thatcher assemblage from the Bonneville deposits reported by Call indicates a difference in age.

Bright is continuing his studies of the Cleveland area as a Ph. D. thesis at the University of Minnesota (R. C. Bright, personal communication, November 4, 1960). In this connection it is expected that he will make the first application of palynology to the Bonneville problem.

SYSTEMATIC CATALOG

The general arrangement of this section follows my previous (1961) checklist, to which the numbers in parentheses are keyed. Only primary sources are cited, and only those records having stratigraphic significance are included except those of material from the Bear Lake area which lack context.

Margaritiferidae

(1) Margaritifera margaritifera (L.) Post-Bonneville (Post-Provo), Sevier Desert. Call 1884: 14.

Unionidae

(2) Anodonta californiensis Lea. "Fossil" at Bear Lake, Utah. Henderson 1931b: 109-113.

(3) Anodonta nuttalliana Lea. Post-Bonneville (Post-Provo), Sevier Desert. Call 1884: 14-15. "Fossil" at Bear Lake, Utah. Chamberlin and Jones 1929: 23, 26.

(4) Anodonta oregonensis Lea. "Fossil" at Bear Lake, Utah. Chamberlin and Jones 1929: 24-25.

(5) Anodonta sp. Kansan stage. Saltair core, sample 140, 433-433 ft. 2.5 in. Eardley and Gvosdetsky 1960: 1336-1338.

Sphaeriidae

(6) Pisidium compressum Prime. "Fossil" at Bear Lake, Idaho and Utah. Henderson 1931b: 109-113.

(7) Pisidium sp. Provo fm., clay member. Near Utah Lake, NE 1/4 Sec. 35, T. 5 S., R. 1 W. Hunt, Varnes, and Thomas 1953: 25. -- Yarmouthian stage. Saltair core, sample 127, 397'5" - 397'7". Eardley and Gvosdetsky 1960: 1336-1338. --- Kansan stage. Saltair core, sample 151, 463'10.5" - 464'0.5". Eardley and Gvosdetsky 1960: 1336-1338.

(8) Sphaerium dentatum (Haldeman). Post-Bonneville (Post-Provo), Sevier Desert; near mouth of Jordan River. Call 1884: 15.

(9) Sphaerium pilsbryanum Sterki. "Fossil" at Bear Lake, Utah. Sterki 1909: 141; Chamberlin and Jones 1929: 32; Henderson 1931b: 109-113. -- Bonneville marl (White Marl). Salt Lake City, west side of Jordan River. Berry and Crawford 1932: 55-54. -- Provo fm., clay member. Near Utah Lake, NE 1/4 Sec. 35, T. 5 S., R. 1 W. Hunt, Varnes, and Thomas 1953: 25.

(10) Sphaerium striatinum (Lamarck). Wisconsinan I stage. Saltair core, sample 59, 186'8"-187'. Eardley and Gvosdetsky 1960: 1336-1338.

(11) Sphaerium sp. Wisconsin I stage. Saltair core, sample 50, 155'6.5"-155'8.5". Eardley and Gvosdetsky 1960: 1336-1338. -- Sangamon stage. Saltair core, sample 82, 271'4"-271'6". Eardley and Gvosdetsky 1960: 1336-1338.

Physidae

(13) Physa ampullacea Gould. "Fossil" at Bear Lake, Utah and Idaho. Henderson and Daniels 1917: 58; Henderson 1931b: 109-113. -- Bonneville marl (White Marl). Salt Lake City, west side of Jordan River. Berry and Crawford 1932: 53-54. -- Provo fm., clay member. Near Utah Lake, NE 1/4 Sec. 35,

T. 5 S., R. 1 W. Hunt, Varnes, and Thomas 1953: 25.

(14) Physa gyrina Say. Upper Bonneville beds (White Marl). Salt Spring Creek, Utah. Call 1884: 18.

(15) Physa heterostropha (Say). Semi-fossil (Post-Provo), Sevier Desert. Call 1884: 18.

(16) Physa lordi Baird. Provo fm., clay member. Near Utah Lake, NE 1/4 Sec. 35, T. 5 S., R. 1 W. Hunt, Varnes, and Thomas 1953: 25.

(17) Physa sp. (spp.). Wisconsinan I stage. Saltair core, sample 57, 178'8"-178'10". Eardley and Gvosdetsky 1960: 1336-1338. -- Kansan stage. Saltair core, sample 140, 433' - 433'2.5". Eardley and Gvosdetsky 1960: 1336-1338.

Lymnaeidae

(19) Lymnaea bonnevillensis (Call). Upper Bonneville beds (White Marl). Kelton, Fish Spring Valley, and near Willow Springs. Call 1884: 18, 24, 28; Call 1886: 5-6. -- Marl deposit (White Marl). South of Sevier Lake, Millard Co., Utah. Hasler and Crawford 1938: 25-26. -- White Marl. Whirlwind Valley, Tooele Co., Utah. Ives 1946: 195-199. -- White Marl. Gilbert's Upper River bed site. T. 10 S., R. 9 W., Tooele Co., Utah. Ives 1951: 787.

(20) Lymnaea caperata Say. -- Sangamonian stage. Sample 82, 271'4" - 271'6". Eardley and Gvosdetsky 1960: 1336-1338. -- Yarmouthian stage. Sample 139, 428'7" - 428' 10". Eardley and Gvosdetsky, 1960: 1336-1338.--Kansan stage. Sample 151, 463'10.5" - 464'0.5". Sample 141, 435' 11" - 436' 1". Eardley and Gvosdetsky 1960: 1336-1338.

(21) Lymnaea catascopium Say. Bonneville Marl (White Marl). Packard 1877: 166.

(22) Lymnaea cockerelli (Pilsbry and Ferriss). Kansan stage. Saltair core, sample 141, 435' 11" - 436' 1". Eardley and Gvosdetsky 1960: 1336-1338.

(23) Lymnaea dalli (Baker). Wisconsinan I stage. Saltair core, sample 57, 178' 8" - 178' 10". Eardley and Gvosdetsky 1960: 1336-1338.

(24) Lymnaea desidiosa Say. Bonneville Marl (White Marl). Packard 1877: 166.

(26) Lymnaea kingi (Meek). Bonneville Marl (White Marl). Salt Lake City, west side of Jordan River. Berry and Crawford 1932: 53-54.

(29) Lymnaea palustris (Müller). Upper Bonneville Beds (White Marl). Near Salt Spring Creek, Utah. Call 1884: 17. -- "Fossil" at Bear Lake, Idaho. Henderson 1931b: 109-113. -- Bonneville marl (White Marl). Salt Lake City, west side of Jordan River. Berry and Crawford 1932: 53-54. -- Wisconsinan I stage. Saltair core, sample 57, 178' 8" - 178' 10". Eardley and Gvosdetsky 1960: 1336-1338. -- Yarmouthian stage. Saltair core, sample 127, 397' 5" - 397' 7". Eardley and Gvosdetsky 1960: 1336-1338.

(30) Lymnaea proxima Lea. "Fossil" at Bear Lake, Idaho. Henderson and Daniels 1917: 58.

(-) Lymnaea stagnalis. Semi-fossil (Post-Provo). Call 1884: 17.

(31) Lymnaea stagnalis appressa (Say). White Marl, Sevier Desert. Baker 1911: 146-147.

(32) Lymnaea sumassi Baird. Upper Bonneville beds (White Marl). Matlin Pass. Call 1884: 18.

(33) Lymnaea utahensis (Call). "Fossil" at Bear Lake, Idaho and Utah. Sterki 1909: 142; Henderson 1924: 173; Chamberlin and Jones 1929: 143-144; Henderson 1931a: 77-79; Henderson 1931b: 109-113. -- Bonneville Marl (White Marl). Salt Lake City, west side of Jordan River. Berry and Crawford 1932: 53-54. -- Provo fm., silt member. Denver and Rio Grande R. R. cut, SE corner Sec. 26, T. 6 S., R. 1 W. Hunt, Varnes, and Thomas 1953: 23.

(34) Lymnaea sp. (spp.). Uppermost Bonneville Terrace (Bonneville fm. ?) 0.5 mile NW Camp Williams, near Utah-Salt Lake Co. line. Crawford and Chorney 1944: 135-138. -- Laufen stage. Saltair core, sample 19, 33' 10" - 33' 11". Eardley and Gvosdetsky 1960:

1336-1338. -- Illinoian stage. Saltair core, sample 115, 358' 8" - 358' 10". Eardley and Gvosdetsky 1960: 1336-1338. -- Yarmouth stage. Saltair core, sample 137, 425' 1" - 425' 3", (2 species). Eardley and Gvosdetsky 1960: 1336-1338. -- Kansan stage. Saltair core, sample 140, 433' - 433' 2.5"; sample 151, 463' 10.5" - 464' 0.5"; sample 162, 493' 8" - 493' 11". Eardley and Gvosdetsky 1960: 1336-1338.

Planorbidae

(35) Armiger crista (L.). Sangamon stage. Saltair core, sample 82, 271' 4" - 271' 6". Eardley and Gvosdetsky 1960: 1336-1338.

(36) Carinifex atopus Chamberlin and Jones. "Fossil" at Bear Lake, Utah. Chamberlin and Jones 1929: 156-157; Henderson 1931a: 77-79.

(37) Carinifex newberryi (Lea). "Fossil" at Bear Lake, Utah. Sterki 1909: 147; Chamberlin and Jones 1929: 155-156; Henderson 1931a: 77-79; Henderson 1931b: 109-113. -- Provo fm., clay member. Near Utah Lake, NE 1/4 Sec. 35, T. 5 S., R. 1 W. Hunt, Varnes, and Thomas 1953: 25.

(39) Gyraulus circumstriatus (Tryon). Laufen stage. Saltair core, sample 25, 44'-44' 2". Eardley and Gvosdetsky 1960: 1336-1338. -- Wisconsinan I stage. Saltair core, sample 57, 178' 8" - 178' 10". Eardley and Gvosdetsky 1960: 1336-1338. -- Yarmouthian stage. Saltair core, sample 119, 366' - 366' 2". Eardley and Gvosdetsky 1960: 1336-1338. -- Kansan stage. Saltair core, samples 140, 141, 153, 162. Eardley and Gvosdetsky 1960: 1336-1338.

(40) Gyraulus parvus (Say). "Fossil" at Bear Lake, Idaho. Henderson and Daniels 1917: 50. -- Laufen stage. Saltair core, sample 33, 75' 10" - 75' 12". Eardley and Gvosdetsky 1960: 1336-1338. -- Wisconsinan I stage. Saltair core, sample 50, 155' 6.5" - 155' 8.5". Eardley and Gvosdetsky, 1960: 1336-1338. -- Yarmouthian stage. Saltair core, sample 129, 402' 1.5" - 402' 3.5". Eardley and Gvosdetsky, 1960: 1336-1338.

(41) Gyraulus vermicularis (Gould). "Fossil at Bear Lake, Utah and Idaho. Henderson 1931b: 109-113. Bonneville Marl (White Marl). Salt Lake City, west side of Jordan River. Berry and Crawford 1932: 53-54.

(42) Gyraulus sp. (spp.). Wisconsinan I stage. Saltair core, sample 49, 145' - 145' 2". Eardley and Gvosdetsky 1960: 1336-1338. Sangamon stage. Saltair core, sample 82, 271'4" - 271' 6". Eardley and Gvosdetsky 1960: 1336-1338. Illinoian stage. Saltair core, sample 115, 358' 8" - 358' 10". Eardley and Gvosdetsky 1960: 1336-1338. -- Yarmouthian stage. Saltair core, sample 127, 397' 5" - 397' 7"; sample 128, 399' 5". Eardley and Gvosdetsky 1960: 1336-1338. -- Kansan stage. Saltair core, sample 142, 437' 2" - 437' 4"; sample 151, 463' 10.5" - 464' 0.5". Eardley and Gvosdetsky 1960: 1336-1338.

(44) Helisoma trivolvis (Say). "Fossil" at Bear Lake, Idaho. Henderson 1931b: 109-113. -- Post-Bonneville (Post-Provo), Sevier Desert, Utah. Call, 1884: 16. -- Upper Bonneville beds (White Marl). Near Salt Spring Creek, Utah. Call 1884: 16. -- Bonneville Marl (White Marl). Salt Lake City, west side of Jordan River. Berry and Crawford 1932: 53-54.

(45) Helisoma sp. Uppermost Bonneville terrace (Bonneville fm.?). Half mile NW Camp Williams, near Utah-Salt Lake Co. line. Crawford and Chorney 1944: 135-138. -- Laufen stage. Saltair core, sample 33, 75' 10" - 75' 12". Eardley and Gvosdetsky 1960: 1336-1338. -- Wisconsinan I stage. Saltair core, sample 49, 145' - 145' 2". Eardley and Gvosdetsky 1960: 1336-1338. -- Yarmouthian stage. Saltair core, sample 128, 399' 5"; sample 139, 428' 7" - 428' 10". Eardley and Gvosdetsky 1960: 1336-1338. -- Kansan stage. Saltair core, sample 140, 433' - 433' 2.5"; sample 141, 435' 11" - 436' 1"; sample 151, 463' 10.5" - 464' 0.5"; sample 162, 493' 8" - 493' 11". Eardley and Gvosdetsky 1960: 1336-1338.

(46) Pompholopsis whitei Call. Provo fm., clay member. Near Utah Lake, NE 1/4 Sec. 35, T. 5 S., R. 1 W. Hunt, Varnes and Thomas 1953: 25.

(47) Promenetus exacuous (Say). Sangamon stage. Saltair core, sample 82, 271' 4" - 271' 6". Eardley and Gvosdetsky 1960: 1336-1338. "Fossil" at Bear Lake, Idaho, Henderson 1931b: 109-113.

(48) Promenetus umbilicatellus (Cockerell). Kansan stage. Saltair core, sample 140, 433' - 433' 2.5". Eardley and Gvosdetksy 1960: 1336-1338.

Ancylidae

(49) Ferrissia sp. Illinoian stage. Saltair core, sample 115, 358' 8" - 358' 10". Eardley and Gvosdetsky 1960: 1336-1338.

Amnicolidae

(50) Amnicola cincinnatiensis (Anthony). Bonneville Marl (White Marl). Floor of Clinton's Cave near Lake Point, Tooele Co., Utah. Packard 1887: 166.-- Upper Bonneville beds (White Marl). "Various localities in Utah." Call 1884: 20-21. -- Marl (White Marl). South of Sevier Lake, Millard Co., Utah, Hasler and Crawford 1938: 25-26. -- Bonneville Terraces (Bonneville fm.?). Pilsbry 1899: 122.

(-) Amnicola decisa Haldeman. Bonneville Marl (White Marl). Bottom of Clinton's Cave, near Lake Point, Tooele Co., Utah. Packard 1877: 165.

(52) Amnicola limosa Say. Bonneville Marl (White Marl). Packard 1877: 166.

(53) Amnicola longinqua Gould. "Fossil" at Bear Lake, Utah and Idaho. Henderson 1931b: 109-113. -- White Marl. Whirlwind Valley, Tooele Co., Utah. Ives 1946: 195-199. -- White Marl. Gilbert's Upper River Bed site, T. 10 S., R. 9 W., Tooele Co., Utah. Ives 1951: 787. -- Provo fm., silt member. Denver & Rio Grande R.R. cut, SE corner Sec. 26, T. 6 S., R. 1 W., Utah Co. Hunt, Varnes, and Thomas 1953: 23.

(54) Amnicola porata (Say). Upper Bonneville Beds (White Marl). "Various localities." Call 1884: 21.

(55) Amnicola sp. (spp.). Wisconsinan I stage. Saltair core, sample 59, 186' 8" - 187'. Eardley and Gvosdetsky 1960: 1336-1338. -- Yarmouthian stage. Saltair core, sample 128, 399' 5"; sample 129, 402' 3.5". Eardley and Gvosdetsky 1960: 1336-1338. -- Provo fm., clay member. Near Utah Lake, NE 1/4 Sec. 35, T. 5 S., R. 1 W. Hunt, Varnes, and Thomas 1953: 25.

(57) Fluminicola fusca (Haldeman). "Fossil" at Bear Lake. Sterki 1909: 142; Henderson 1931b: 109-113. -- Bonneville Marl (White Marl). Packard 1877: 166. -- Upper Bonneville beds (White Marl). Kelton; Snowville, Box Elder Co., Utah. Call 1884: 21. -- Bonneville Marl (White Marl). West side of Jordan River, Salt Lake City. Berry and Crawford 1932: 53-54. -- Provo fm., silt member. Denver & Rio Grande R.R. cut, SE corner Sec. 26, T. 6 S., R. 1 W. Hunt, Varnes, and Thomas 1953: 23, 25. -- Provo fm., clay member. Near Utah Lake, NE 1/4 Sec. 35, T. 5 S., R. 1 W. Hunt, Varnes, and Thomas 1953: 23-25.

(-) Pomatiopsis lapidaria Say. Bonneville Marl (White Marl). Bottom of Clinton's Cave, near Lake Point, Tooele Co., Utah. Packard 1877: 166.

(59) Pomatiopsis lustrica Say. Bonneville Marl (White Marl). Packard 1877: 166.

Valvatidae

(62) Valvata humeralis (Say). Laufen stage. Sample 33, 75' 19" - 75' 12"; sample 37, 88' 6" - 88' 8". Eardley and Gvosdetsky 1960: 1336-1338. -- Wisconsinan I stage. Sample 49, 145' - 145' 2"; sample 50, 155' 6.5" - 155' 8.5"; sample 55, 173' 4" - 173' 6"; sample 57, 178' 8" - 178' 10". Eardley and Gvosdetsky 1960: 1336-1338. -- Sangamonian stage. Sample 82, 271' 4" - 271' 6". Eardley and Gvosdetsky 1960: 1336-1338. Yarmouthian stage. Sample 117, 363' - 363' 2"; sample 119, 366' - 366' 2"; sample 127, 397' 5" - 397' 7"; sample 128, 399' 5"; sample 129, 402' 1.5" - 402' 3.5"; sample 139, 428' 7" - 428' 10". Eardley and Gvosdetsky 1960: 1336-1338. -- Kansan stage. Sample 140, 433' - 433' 2.5"; sample 142, 437' 2" -

437' 4"; sample 151, 463' 10.5" - 464' 0.5"; sample 153, 469' 10" - 470'; sample 162, 493' 8" - 493' 11"; sample 174, 534' 10.5"-535'. Eardley and Gvosdetsky 1960: 1336-1338.

(63) Valvata humeralis californica Pilsbry. "Fossil" at Bear Lake, Utah and Idaho. Henderson 1931b: 109-113. Bonneville Marl (White Marl). Packard 1877: 166. Salt Lake City, west side of Jordan River. Berry and Crawford 1932: 53-54.

(64) Valvata utahensis (Call). "Fossil" at Bear Lake, Idaho and Utah. Henderson 1931b: 109-113. Bonneville Marl (White Marl). Salt Lake City, west side of Jordan River. Berry and Crawford 1932: 53-54. -- Laufen stage. Sample 33, 75' 10" - 75' 12". Eardley and Gvosdetsky 1960: 1336-1338. -- Wisconsinan I stage. Sample 49, 145' - 145' 2"; sample 50, 155' 5.5" - 155' 8.5". Eardley and Gvosdetsky 1960: 1336-1338. -- Yarmouthian stage. Sample 129, 402' 1.5" - 402' 3.5". Eardley and Gvosdetsky 1960: 1336-1338. -- Provo fm., sand member. Utah Co., Sec. 32, T. 4 S., R. 1 E. Hunt, Varnes, and Thomas 1953: 23. -- Provo fm., clay member. Near Utah Lake, NE 1/4 Sec. 35, T. 5 S., R. 1 W. Hunt, Varnes, and Thomas 1953: 25.

(66) Valvata virens Tryon. Semi-fossil (Post-Provo), Sevier Desert. Call 1884: 21.

Camaenidae

(68) Oreohelix strigosa depressa (Ckll.). Provo fm., silt member. Dry Creek, just below town of Alpine, Utah Co. Hunt, Varnes, and Thomas 1953: 24.

Endodontidae

(73) Discus cronkhitei anthonyi Pilsbry. "Fossil" at Bear Lake, Idaho and Utah. Henderson and Daniels 1917: 58; Henderson 1931b: 109-113.

Pupillidae

(76) Vertigo ovata (Say). "Fossil"? at Bear Lake, Idaho. Henderson and Daniels 1917: 58.

Succineidae

(77) Succinea avara Say. Provo fm., silt member. Dry Creek, just below town of Alpine, Utah Co. Hunt, Varnes, and Thomas 1953: 24.

(78) Succinea lineata W. G. Binney. Bonneville Marl (White Marl). Packard 1877: 166.

(79) Succinea sp. (spp.). "Fossil" ? at Bear Lake, Idaho. Henderson 1931b: 109-113. -- Sangamon stage. Saltair core, sample 82, 271' 4" - 271' 6". Eardley and Gvosdetsky 1960: 1336-1338.

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HELICODISCUS ROUNDYI (MORRISON)

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In my recent paper "Drift land shells from the Red River, Arkansas" (Sterkiana 8: 33-34) I listed two new species of *Helicodiscus*. One of these, of which there were five specimens, was a very small, tightly coiled species, only slightly larger than *Punctum minutissimum* (Lea). While the above paper was in press I succeeded in removing the dirt from the apertures of the shells and discovered that there was a pair of teeth within the aperture. This discovery enabled me to identify them as *Paravitrea roundyi* Morrison. Having examined these specimens I feel that this species belongs in *Helicodiscus* rather than *Paravitrea*.

Three shells which I had collected in 1934 from Pleistocene silt, one mile northwest of Collinsville, Madison County, Illinois were found to be *Helicodiscus roundyi*. One specimen had three pairs of teeth within the aperture.