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Samuel J. Tuthill

University of North Dakota

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MOLLUSKS FROM WISCONSINAN (PLEISTOCENE) ICE-CONTACT SEDIMENTS
OF THE MISSOURI COTEAU IN CENTRAL NORTH DAKOTA

by
Samuel J. Tuttle
A.B. Drew University 1951
M.S. Syracuse University 1960

A Thesis
Submitted to the Faculty
of the
Graduate School
of the
University of North Dakota
in partial fulfillment of the requirements
for the Degree of
Master of Arts

Grand Forks, North Dakota
June 1963
This thesis submitted by Samuel J. Tuthill in partial fulfillment of the requirements for the Degree of Master of Arts in the University of North Dakota, is hereby approved by the Committee under whom the work has been done.

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Chairman

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Dean of the Graduate School
MOLLUSKS FROM WISCONSINIAN (PLEISTOCENE) ICE-CONTACT SEDIMENTS
OF THE MISSOURI COTEAU IN CENTRAL NORTH DAKOTA

Samuel J. Tuthill, A.B., B.S., M.A.

ABSTRACT

This thesis here abstracted was written under the direction of
Frank O. Holland, Jr., and was approved by William H. Laird and George
C. Wheeler as members of the examining committee, of which Dr. Holland
was Chairman.

Geologic and paleontologic evidence indicates that numerous
mesotopic, temperate, water bodies were present while drift-covered
blocks of stagnant glacier ice, emplaced during Woodfordian (late
Wisconsinan, Pleistocene) time, underlay the Missouri Coteau district
(approximately 50 by 300 miles in extent) in central North Dakota.

Fossil mollusks, contained in sediments deposited in contact with
the stagnant ice at 40 sites, are represented by 23 species including
paleopods of the families Unionidae and Sphaeriidae and gastropods
of the families Valvatidae, Hydrobiidae, Physidae, Lymnaeidae,
Planorbidae, Ampullidae, Succinidae and Papillidae. Naïd shells
have provided material for five radiocarbon dates in the Missouri
Coteau district which indicate that the melting of the stagnant ice
may have required 2,100 years.

The fossil mollusks, as now known, do not serve as stratigraphic
indices to the late Pleistocene deposits of the region, but the species
composition of fossil molluscan communities dominated by the branchiate
genera Velvilia and Ancicola is regarded as tentative evidence of the
pre-Holocene age of the Missouri Coteau sediments. The mollusks also indicate the climate of the region to have been mild and humid as early as 12,000 and as late as 8,700 radiocarbon years before the present.
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MOLLUSKS FROM WISCONSINIAN (PLEISTOCENE) ICE-CONTACT SEDIMENTS
OF THE MISSOURI COTEAU IN CENTRAL NORTH DAKOTA

by
Samuel J. Tuthill

INTRODUCTION

The discovery of fossil mollusks in the drift of south-central North Dakota by three independent field parties in the summer of 1961 provided valuable information for the interpretation of the glacial geology of the Missouri Coteau district (Fig. 1). Detailed investigation of the fauna at three sites was reported by Clayton (1961) and of another site by Tuthill (1961). These and 36 additional sites and their faunas are described here. Shell material from five of these has been radiocarbon dated (Fig. 20).

The drift from which the fossils were taken was deposited on stagnant ice in a belt as great as 50 miles wide, comprising the Missouri Coteau district as restricted by Lambe and Colton (1938, Fig. 1) in southern North Dakota. The presence of fossil fresh-water gastropods and pelecypods provides an excellent basis for reconstructing the ecologic conditions which prevailed during the formation of the Missouri Coteau. The pelecypods of the superfamily Nassinae also provide material for radiocarbon dating of the sediments.

The large number of species (23) and the complexity of the life history of some of them, provide information about the type of community of which they were a part and are presumptive evidence for a timeable biota not represented by fossil remains. That the mulluscan fauna will provide fossil indices to geologic time is unlikely for two reasons. First, no extinct forms have been found in the drift of North Dakota. Although little detail is yet known of the Recent fauna, all of the species are still extant in some part of the state. Secondly, insufficient time elapsed during the deposition of the drift of which the fossils are a part, to expect evolutionary changes in the species and no morphologic differences between Wisconsinan specimens and Recent specimens has been observed.

Traditionally, Pleistocene time divisions have been erected on lithologic criteria which are assumed to reflect climatic conditions. Those climatic conditions which caused continental glaciers to advance and those which caused them to contract are inferred from tills and paleosols respectively. It must be remembered that these tills and paleosols are proper criteria for inferring lithologic equivalency, but they are not proper criteria for time correlations unless they are supported by independent time indicators such as fossil indices. However, the technique of lithologic equivalence seems usable for the larger divisions of Pleistocene time (stages) in areas where lithologic evidence for multiple glaciations are present and well exposed. The equating of lithologies in this latter manner assumes that climatic conditions which controlled the several glaciations of the Pleistocene are known in detail and that they varied at essentially the same time across the latitudes of North America and northern Europe. The validity
Fig. 1. INDEX MAP OF NORTH DAKOTA SHOWING THE MISSOURI COTEAU AND COTEAU SLOPE DISTRICTS AND THE AREA STUDIED. Approx. Scale 1:2,500,000.
Fig. 2. MAP OF THE AREAS SHOWING DRAINAGE PATTERN. Note integrated drainage in Coteau Slope district in western Burleigh County, Emmons County and western McIntosh County and total lack of integrated drainage in the Missouri Coteau district.
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expression, whose expression cycle have been obtained, indicates that
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...the hope of existing now final results for the ice rise scenario,

...were made of the molluscous frame of the shrunken outer shell, are probably

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...order of subregions are considered.

...of these occurrences is not beyond question when the distribution of the

10
Fig. 3. Classification of the Wisconsinan stage in North Dakota. This classification is a modification of that of Frye and Williams (1960). Substages older than the Woodfordian are not known in the Missouri Coteau district.
in the atmosphere at any given time seems more reasonable than the idea
that glacial advance and retreat would vary uniformly in the dimensions
of a substage across the northern hemisphere. Thus the fact that the
ratio may not be the same today as it was in the past is not a critical
flaw. A radiocarbon date in one area has an excellent chance of
representing the same number of solar years as a similar radiocarbon
date in another area despite the fact that radiocarbon years may not
equal solar years.

The physiology of the assimilation of carbon by aquatic mollusks
has been studied by Rubin and others (1963, p. 84-86). Their study on
gastropods indicates a maximum reductional error of approximately
1000 C\(^14\) years is possible in dates taken from shells. If this error
approximates that possible in maimed shell dates, it does not signifi-
cantly alter the conclusions drawn here. Dates on wood (Moir, 1930,
p. 110, 1-542, on conifer wood from 50°, sec. 25, T. 138 N., R. 71 W.,
11,480 = 300 years B.P.) in Kittery County in the Missouri Cotene district
closely agrees with the dates obtained from maimed shells. With this
good degree of agreement I assume that the method of radiocarbon dating
of aquatic mollusk shells is valid.

I have not adopted the substage names of Frye and Killman for time
divisions older than the Woodfordian because the dates obtained from
the Cotene do not as yet require it.
PLEISTOCENE GEOLOGY

Wisconsin Stage Stratigraphy:— All the fossils discussed here are from a single Pleistocene stratigraphic unit, the Burnstead Drift (as defined by Clayton, 1963, p. 62). The Burnstead Drift is a glacial morhostratigraphic unit consisting of till, outwash and lake sediments of the Burnstead and Streeter end moraines and associated dead-ice moraines, outwash plains, and ice-contact washed-drift features in south-central North Dakota. Fossilized (maids) shells from it have been radiocarbon dated at as little as 8,700 and as much as 11,960 years before present (see Fig. 20). The Burnstead Drift belongs to the upper part of the Wisconsinan Stage. The drift-covered stagnant ice from which the Burnstead Drift was deposited might thus have taken 2,100 years to melt. The end moraines that are composed of Burnstead Drift, deposited when the ice was active, roughly correlate with end moraine composed of Manhasset Drift in Minnesota according to Clayton (1963, p. 66). The topographic features in which the fossils were found are composed of Burnstead Drift deposited in contact with the glacier ice after the ice stagnated. It correlates, in part, with the Two Creeks deposits in Wisconsin and possibly also with Valders and post-Valders deposits. The upper Burnstead Drift is thus part of Frye and Willman's (1960) Two Creeks and Valders substages (Fig. 3), but was probably emplaced by ice which invaded North Dakota during Woodfordian time.

Ice-Contact Deposits of the Burnstead Drift:— All of the fossiliferous sediments of the Burnstead Drift are ice-contact deposits of outwash or lake sediments that resulted when sheets of glacier ice, several miles wide, stagnated. These deposits occur in a variety of
forms, including ice-moulded-lake plains, collapsed lake-sediment
topography, and collapsed outwash topography.

The ice-moulded-lake plains are as much as 5 miles across and
are bordered by outward sloping ice-contact faces. The present
topography of the Coteau is essentially the same as the glacier
left it. Because the drainage of the Coteau is completely uninte-
grated, the elevated positions of the lake plains could only result
from deposition in lakes that were surrounded by stagnant glacier
ice. (Fig. 2). The collapsed outwash topography and collapsed-lake-
sediment topography were formed during the melting of ice on which
had been deposited sediments from supraglacial streams and lakes
(Fig. 4 and 5). The resulting collapsed outwash and lake sediment
has bedding that is gently to complexly folded and faulted. Its
topography has as much as 100 feet of local relief and has numerous
undrained depressions, indicating that the relief is the result of
collapse from stagnant ice rather than the result of stream erosion.
Stream sediments are frequently found distributed over hills and
depressions with no logical genetic relationship to the present
topography.
Fig. 4. SCHEME SHOWING THE MANNER IN WHICH ICE-WALLED LAKES MAY HAVE FORMED IN THE MISSOURI COTEAU DISTRICT DURING WISCONSINAN TIME. The biota is inferred from fossil remains.
Fig. 5. SCHEMATIC DRAWING SHOWING THE RELATIONSHIP OF LITHOLOGIES AND THEIR TOPOGRAPHIC EXPRESSIONS IN THE MISSOURI COTEAU DISTRICT OF SOUTH-CENTRAL NORTH DAKOTA. The area is presently typified by a total lack of integrated drainage.
METHODS

Most of the samples were located by geologists in the normal course of field mapping the surface geology of the state. Tailings at the entrance of beaver burrows were of great assistance in locating fossiliferous sedimentary layers which were not exposed at the surface.

All sites required extensive excavation by digging a pit or trench before successful examination and sampling was possible. As a result, most of the knowledge I have is of the sediments near the surface. Nowhere was I able to sample to a depth where till or bedrock was encountered.

The fragile nature of the saline mollusks necessitated a special collecting technique. The clam shells, partially exposed by excavation, were saturated with clear lacquer sprayed from a pressure bomb and allowed to dry before they were removed from the sediments. They were then removed from the sediments, again sprayed with lacquer and wrapped in tissue paper for transportation. With this technique it was possible to recover specimens in such perfect condition that they still show fibers of the ligament. The larger specimens of the genera <i>Sphaerium</i>, <i>Haliotis</i>, and <i>Lymnea</i> were collected from the sediments as they were encountered. All other specimens were taken in bulk samples and removed from washed samples during examination of the sediments under binocular microscope at magnifications of 10 X, 60 X, and 120 X. About one-half liter of sediments was examined from each sample and a representative fauna removed, placed in vials, identified, catalogued and placed in the collection of the University of North Dakota Department of Geology. Approximately 15,000 specimens comprise the basis of the conclusions drawn here.
At several sites, detailed descriptions of the sediments were made and sequential samples were taken (Nue Farm, Mummy Cat Slough, Necanthai 1, Necanthai 2, Cleveland and Scheuer Farm sites). The results of the inspection of these samples for fauna and grain size of sediments are combined with the information obtained in the field and presented in graphic form in Fig. 8, 9, 12-16.

All measurements of fossils listed below were taken in the following manner:
Measurements less than 1 mm were made with an ocular grid at magnifications of 45 x, with an implied accuracy of 0.03 mm.
Measurements of 1 - 10 mm were made with an ocular grid at magnifications of 15 x, with an implied accuracy of 0.1 mm.
Measurements greater than 10 mm were made with a vernier calipers with an implied accuracy of 0.1 mm.

Shell orientation in the case of the genera *Sphaerium* and *Pliatium* follows. In *Pliatium*, the apical terminations of the lateral teeth form two points on a line of reference; shell length is the greatest distance parallel to this line in the plane of commissure, and shell height is the greatest distance normal to this line in the same plane.
For *Sphaerium* a plane of approximate secondary symmetry can be imagined passing through the banks and dividing the ventral margin into anterior and posterior halves; the juncture of this plane and the plane of commissure forms a line of reference. Shell length for *Sphaerium* is the greatest distance in the plane of commissure normal to this line; shell height is the greatest distance parallel to the line. Thickness of the peduncles was not measured because single valves were more
common than articulated ones.

Shell orientations employed in all other genera, as well as these special cases may be seen in Fig. 21.

The fragility of the specimen precluded an attempt to match disjunct valves. Articulated naid shells were left with their contained sediments intact. The interiors of the shells were inspected through holes bored in the impregnated sediment fillings.
ACKNOWLEDGMENTS

I am indebted to several persons who facilitated the research reported here. Dr. F. D. Holland, Jr., under whose direction this thesis was written, gave freely of his time, advice, and efforts throughout the research and subsequent writing. His encouragement was in large measure responsible for my continued enthusiasm for the study. Dr. Wilson H. Laird has supported my efforts, both personally in the form of advice, parallel research participation, and encouragement and by providing support for part of the field work and the photographing of the plates, in his capacity as State Geologist. Dr. George C. Wheeler has been most helpful in assisting me to gain an understanding of the Recent molluscan fauna of North Dakota, which serves as the basis of the paleoecologic reconstructions postulated here.

Mr. Lee S. Clayton worked with me in the field from time to time. Through his own research he set the geologic scene for this study. The conversations I was privileged to have with him during the period 1960 to 1962 contributed greatly to my understanding of the Pleistocene history of the Missouri Coteau district, and this report would be far less complete were it not for his efforts. Mr. Dan E. Hansen, Geologist of the North Dakota Geological Survey, and Mr. Neil R. Sherrard, Graduate Student at the University of North Dakota, were attentive to my problem, while engaged in their own research, and their collection of fossiliferous sites in Burleigh and Divide and Sheridan Counties has extended the area of our knowledge of Wisconsinan molluscan faunas very measurably.
Mr. Miller Hansen, Assistant State Geologist, Mr. Jack Kuma and Mr. Kent Haugenfeld, of the North Dakota Geological Survey have contributed to the study in the form of actual assistance in the field, suggestions and criticisms and I wish to express my appreciation of their interest and efforts.
BOLUSICA AS PALEOECOLOGIC INDICATORS

The practice of inferring ecologic and climatic conditions which existed in the past, from fossils by assuming their environmental requirements to be essentially identical with those of extant relatives, is well established and correct under the assumptions implicit in the doctrine of Uniformitarianism. In the case of the Pleistocene mollusks reported here it is most appropriate, as all of the species are extant and resident in the same general geographic region as the fossils. The ecologic differences between the present loca of the living forms and the Coteau can be regarded as the net ecologic change which has occurred between the time of the deposition of that part of the Burnstead Grift containing the fossil mollusks and the present. A discussion of this has been given by Tuthill, Clayton, and Laird (1963).

Because any lotic and/or lacustrine environment is composed of a variety of microhabitats which may differ from each other to a striking degree, the problem of recognizing neocenomases becomes central. An examination of the sediments and the population structure of the fauna usually suffices to indicate the presence or absence of a neocenomase, but at best the conclusion is subjective. Even transported fossils, if not reworked from older rocks, can be regarded as solid paleoclimatic criteria for the general area of the Missouri Coteau.

The question of the importance of variation of numbers of specimens of one species as compared to the number of specimens of another species in a vertical sequence has been raised by LaRueque (1960, p. 141). In an area where a dense sampling pattern can be established, quantitative methods are preferable. The faunas reported here have been treated in a semi-quantitative way as befits the manner of sampling and
the reconnaissance nature of the entire study. Exposures on the Cotese are rare and always shallow. The presence or absence of the various species is a valid basis for conclusions about the ecologic conditions which endured, but are less precise than those permitted by a more quantitative technique.

Present knowledge of the ecology of Recent freshwater mollusks is largely limited to compilations or scattered items of information noted in conjunction with the collection of specimens. Few exhaustive ecologic studies of freshwater mollusks have been conducted, therefore the ecologic information inferred from fossils must remain general in nature if it is to be accurate. The practice of some authors of inferring the conditions of water chemistry and specific temperature ranges is without justification at the present state of knowledge of the habitat requirements of Recent mollusks. The use of fossil communities as a basis for reconstructing climatic conditions of the Pleistocene is quite appropriate, however, in that few species have become extinct and comparable assemblages of the same species now exist in North America to guide the paleoecologist.
TYPES OF HABITATS

The sediments from which fossil mollusks have been taken indicate two basic types of sedimentary environments existed on the Missouri Coteau during late Wisconsinan time: running and standing fresh water. The last of these still exists there, but the first is totally absent. The areal distribution and thickness of lake sediments at 32 sites suggests that a considerable number of standing water environments also existed during the time the fossil mollusks lived. The high position of these lake sediments above collapsed till and outwash sediments is taken as evidence that these lakes were a part of the supraglacial drainage on the ice which deposited the Streeter and the Burnstred end moraines.

Collapsed outwash at 7 sites, containing fossils, some of which show attrition of their surfaces, presumably due to abrasion during transportation, suggest a considerable development of connecting drainage between the lakes, a feature absent from the district at the present time. The smaller number of fossiliferous sites located in outwash sediments may well be due to the greater difficulty of recognizing the presence of fossil mollusks in sand-and gravel-graded sediments.

Gastropods, reputed to be found in lakes only (e.g. G. Helicops, *Caenogastropoda* and *H. Irivoltia*) have been found in 3 of the 7 sites composed of outwash sediments and specimens of *H. antennata*, reputed to be a running water snail, have been found in lake sediments in 10 out of 13 sites where it was a part of the molluscan fauna. The mixing of faunas in sediments deposited by running water is to be expected.
Fossil assemblages probably reflect the settling velocity of the shells more directly than they do the biota which lived at the spot during the time of deposition of the sediments. The presence of stream-living forms in lake-laid sediments can be explained by the deposition of their shells in lakes during high water stages of the streams or by flotation.

The reliability of species as precise ecologic indicators of habitat type is not closed to question. I have reported (Tuthill and Others, 1963) successful communities of *M. annect* from a lake in northwestern Minnesota which lacks inflowing or outflowing permanent streams.

For these reasons, I have assigned the various sites to one or more of the habitat types discussed below primarily on the sediment type from which the fossils were taken. The species composition at each site is in essential agreement with my assignments in that the species could be expected to have either lived in, or been carried to, the environment of deposition from an adjacent habitat more likely to have supplied the ecologic needs of the various species included in it.

Seven habitat types have been constructed on an hypothetical explanation of the aquatic environments which were probably available to the mollusks which lived on the Missouri Coteau about 9,000 to 11,500 years ago. A diagrammatic sketch of these may be seen in Fig. 6.
to capture discharges and thereby lower the downstream concentration of the tracer. To do this would
result in a decrease of tracer concentrations downstream which would decrease the overall concentration of the tracer.

The greater amount of sand, which affects sediment deposition, would then result in a decrease of
the overall concentration of the tracer. This is because the tracer would be deposited in
the sand in the downstream area where the concentration of the tracer is lower.

The downstream area would then experience a decrease in the concentration of the tracer.

These results indicate that the downstream area would experience a decrease in the concentration of the tracer.

Conclusions:

The results of the experiment demonstrated the effectiveness of using radioactive tracers to study the movement of pollutants in the environment. The use of radioactive tracers allowed for precise monitoring of the pollution levels and provided valuable insights into the behavior of pollutants in different environments.

The implications of these findings are significant for environmental management and policy-making. The results suggest that the use of radioactive tracers could be a valuable tool for assessing the impact of pollutants on aquatic ecosystems and for developing effective strategies to mitigate pollution.

In conclusion, the use of radioactive tracers in pollution studies is a powerful technique that can provide valuable insights into the behavior of pollutants in different environments. The results of this study highlight the importance of considering the use of radioactive tracers in pollution studies and suggest that further research in this area is warranted.
The deep lake basin would exist only if

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of habitat. *Helisoma trivolvis* might be present here and *H. complicatum* would be expected along with the branchiataes.

**Type 7. Lake Margin:** Lake margins would be the last habitat type to be expected. The nature of this habitat would vary from beach to marsh, depending on the prevailing wind direction and the outline characteristics of the lake. The marshy type would be expected to have a sediment grain size character not unlike that of habitat types 1, or 6, and possibly 5. The presence of land snails intermixed with aquatic types would possibly indicate this type of habitat and one should expect a large number of pulmonates. The introduction of shells from habitat type 6 by wave action or from any of the other environments by flotation would not be unusual. This habitat type might be subject to great variation if fluctuations of water level were common throughout the season. The greater the fluctuation, the more distinctive this habitat type would be; and the tenous nature of assignments to this habitat may be due to the fact that the water level in the drainages of the Missouri Coteau district were relatively stable throughout the time that mollusks lived there.

It is obvious that these habitats are gradational and the classification erected here is necessarily synthetic. Thus it is reasonable that the species composition of the fossil molluscan fauna would not be expected to provide strict criteria for the assignment of the various sites to a specific habitat type without heavy reliance on sediment type.

Table 6 shows the assignment of the sites to habitat types.
Fig. 6. 1. Backwater in streams—highly oxygenated, unstable environment, mixing of fossil fauna likely.
2. Stream—highly oxygenated, mixing of fauna from up drainage additions, great variety in grain size of sediments.
3. Delta Top—flats, pulmonate fauna dominant, highly unstable environment, mixing likely.
4. Delta Front—relatively firm substrate (for lake environment), shade making flora depressed, highly oxygenated benthic fauna dominant with salins and Helisoma species.
5. Deep Lake—if thermocline present no successful population of pulmonates, benthic forms with etched shells. If thermocline absent benthic forms dominate, but pulmonates may be present. Mollusks less successful here than elsewhere. Oxygen content highly variable.
6. Shallow Lake—greatest variety of species of mollusks.
   Oxygenated. Abundant vegetation and shade. Helisoma anna replaced by H. trivolvis and/or H. complanata.
7. Lake Margin—terrestrial snails may be mixed with aquatic pulmonates. Benthic forms less common. May appear quite like 3 above or 1 above.
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Total: 40 2 4 3 3 2 32 1 1
DESCRIPTION OF FOSSILIFFERUS SITES

The fossiliferous sites of the Missouri Coloma district have been assigned informal names. These names were derived from geographic locations (e.g., Clear Lake site because of its close proximity to Clear Lake, McIntosh County; Florence Lake because of its proximity to Florence Lake, Burleigh County, etc.), township names (e.g., Iowa, Hosenthall, Mannfesthall etc. in which the sites occur), or farm owner's names (e.g., Kue Farm site, Tootber Farm site, etc.). Because of the possibility of frequent changes of ownership I have used the notations in the Platt Book in the library of the North Dakota Geological Survey as the reference for these names.

The locations of the sites are shown on individual county index maps (Fig. 7, 10, 11, 12, 16, and 18).

Stutsman County

A. Cleveland site:- The Cleveland site was studied by Tutkill (1961, p. 19-26). The site is located in the 5¾, sec. 17, T. 139 N., R. 67 W., approximately 2½ miles southwest of the village of Cleveland. Figure 8 shows the lithology of the site. The fossils were transported only a short distance, if at all. Many of the uniled shells were found in sand which was overlain by gravel. Their shells were oriented in a living position and appear to have been buried rapidly; although subsequent compaction has partially crushed the valves. The fossiliferous units are of a grain size consistent with an aquatic environment most favorable for the molluscan community represented by the fossil assemblage (i.e., a slow-moving body of shallow water). Thus, I believe this
Fig. 7. Block map of Stutsman County, North Dakota, showing locations of fossil bone sites.
**Lithology and Vertical Distribution of Mollusks in Cleveland Site (A) Site sec. 17, T. 139 N., R. 67 W., Stutsman County, North Dakota.**
faunule to be a eoceneocene.

**Fossil:**

**Gastropods:**
- *Valvata tricornata*
- *Amnicola limosa*
- *Limninae humilla*
- *Drepanula varva*
- *Drepanula sp.*
- *Haliotis augena*
- *Haliotis sp.*

**Pelecypods:**
- *Anadonta grandis*
- *Anadonta elongata*
- *Pleurotomella altaea*
- *Pleurotomella sp.*
- *likely shell fragments*

**Habitat:** Type 4, Delta Front.

**Gastropalogy:** Naired shells from this site were dated by the
Washington, D. C., laboratory of the U. S. Geological Survey as
having lived 11,070 - 300 years before present (U.S.G.S. Sample
number R-436, Rubin personal communication to Charles Huxsoll,
U.S.G.S., Grand Forks, N. Dak.).

**B. Shauer Farm site:**

This site is located in the sec. 27, T. 137 N., R. 69 W., Stutsman County. Collapsed lake sediments
(Fig. 9) underlie the black soil of most of this quarter section.
The samples which comprise this site were taken from an excavation.
The fauna is probably a eoceneocene.

**Fossil:**

**Gastropods:**
- *Valvata tricornata*
- *Syria linola*
- *Limninae humilla*
- *Haliotis augena*
- *Drepanula varva*
- *Drepanula sp.*
- *Pleurotomella elongata*
- *Pleurotomella sp.*
- *likely shell fragments*

**Pelecypods:**
- *Lonchis radiata siliciumiden*
- *Pleurotomella sp.*
- *likely shell fragments*

**Habitat:** Type 6, Shallow Lake or Type 7, Lake Margin. The presence
of *Gastropoda* in the sediments of this site indicates the nearby
Fig. 9. LITHOLOGY AND VERTICAL DISTRIBUTION OF THE MOLLUSKS IN SCHAUER FARM SITE (B) 5th sec. 29, T. 137 N., R. 69 W., Stutsman County, North Dakota.
Fig. 10. INDEX MAP OF LOGAN COUNTY, NORTH DAKOTA, SHOWING LOCATIONS OF FOSSILIFEROUS SITES.
presence of terrestrial vegetation.

Geochronology: Mollusk shells from the Schauer site were radiocarbon
dated by the Washington, D.C., laboratory of the U. S. Geological
Survey at 9,870 – 290 years before present (sample number X-954,
Sabin, personal communication to Charles Mannell). This site is
behind the Streeter moraine a few miles south and west of the
Cleveland site. It appears that stagnant ice underlay this section
of the Missouri Coteau for at least 1200 years, for the Cleveland
site, 11,070 – 300 years B.P., is closer to the source of the
glacier than is the Schauer farm site, 9,870 – 290 years B.P. The
younger fauna lived at the Schauer site before the final melting
of the ice, but this ice could not have been the product of glacia-
tion more recent than the fauna at the Cleveland site.

Logan County

C. Bidwiek farm site: This site is located in the SW\(\frac{1}{4}\) sec. 9,
T. 136 N., R. 69 W. The deposit is a small body of ice-contact
lake clay at the south edge of a 1½ mile wide ice-contact outwash
plain (Clayton, 1961, p. 13).

Fauna:

Gastropods: 

*Valvata trisulcata*
*Amnicola limosa*
*Cernuella sorra*
*Cernuella sp.*
*Natalina australis*
*N. communis*
*Saccinaea avara*

Mollusk fragments

Habitat: Type B, Shallow Lake. The drift must have been terrest-
rially vegetated, because *Saccinaea avara* requires land plants and
vegetable litter.
D. **Sch_deinit Farm site:** This site is located NW ¼ sec. 26, T. 135 N., R. 68 W. Ice-contact lake silts cap a hill 50 feet high at this site (Clayton, 1961, p. 14).

**Fingga:**

Gastropods:
- Amnicola limosa
- Valvata spicarinosa
- Valvata sp.
- Stranais sarnus
- Frasconeina squamata
- Amnicola spicaria
- Helicoma conchistriata
- Lymnaea anulata
- Planorina sp.

Pelecypods:
- Pilaidea sp.

**Habitat:** Type 6. Shallow Lake.

E. **Gatchmidt Farm site:** This site is located in the NW ¼ sec. 20, T. 135 N., R. 67 W., Logan County. Most of the N.W. 1/4 of this section is surfaced by collapsed lacustrine sediments which are overlain by black wind-blown soil a few inches thick. Nailed shells brought to the surface by plowing were found.

A small amount of transportation of the fossils possibly occurred during deposition, but the fine grain nature of the sediments suggests that they were not carried by strong currents.

**Funga:**

Gastropods:
- Valvata spicarinosa
- Amnicola limosa
- Stranais sp.

Pelecypods:
- Lymnaea anulata
- Nailed fragments

**Habitat:** Type 6. Shallow Lake.

**Geochronology:** Nailed shells from this site were radiocarbon dated at 9,000 - 300 years B.P. by the Washington, D.C., laboratory of the U. S. Geological Survey (Hubbs, personal communication to Wilma N. Laird). The Gatchmidt Farm site lies within the Streeter servaise, and the fauna lived in a lake no doubt insulated from.
but surely underlain by, glacier ice. Thus the glacier which transported the material of this part of the Burnstad Drift preexisted the fauna. This establishes a minimum age of about 9,000 C14 years for this part of the drift, but does not preclude the idea of the Burnstad Drift being older.

F. Brunnssas Farm Site:-- This site is located in the NW sec. 27, T. 125 N., R. 71 W. A four-foot bed of marl overlying an undetermined thickness of dark gray clay comprises the site. The sediments were deposited in an irregular, partly ice-walled lake (Clayton, 1961, p. 13).

**FAMILY:**

**Gastropods:**
- *Valvata tricarinata*
- *Valvata sp.*
- *Amnicola limnea*
- *Syrningia surcata*
- *Pseudonassa commensal*
- *Amnicola cripta*
- *Haliotis trivolvus*
- *Lymnaea sp.*
- *Planorbis sp.*

**Pelecypods:**

**Habitat:**-- Type 6, Shallow Lake.

G. Krocher Site:-- This site is located in the NW cor. sec. 35, T. 125 N., R. 71 W. The bed of sediments which contains the fossil mollusks is a marl in sediments of Glacial Lake Napoleon. Clayton, (1961, p. 16) suggests that this site is probably not an ice contact deposit. It is likely that the sediments and their contained fauna are of late Wisconsin age.

**Family:**

**Gastropods:**
- *Valvata tricarinata*
- *Syrningia surcata*
- *Pseudonassa commensal*
- *Haliotis trivolvus*
- *Planorbis sp.*
- *Lymnaea sp.*
- *Amnicola cripta*
- *Lymnaea stagnaria*
Fig. II. Index map of McIntosh County, North Dakota, showing locations of fossiliferous sites.
Habitat: Type 6, Shallow Lake.

Mahnomen County

6. Buffum small site: This site is located in the NW 1/4, sec. 29, T. 132 N., R. 68 W. The fossils are in marly sand and peat beds which have been distorted by the ice which deposited the Streeter Moraine. The fossils appear to have been transported after death.

**Forma:** Gastropods: *Valvata brevisepalis*
*Amnicola lineata*
*Amnicola sp.*
*Gyrinidae parasae*
*Lymnaea haliotis*
*Lymnaea sp.*
*Helisoma complanatum*
Pelecypods: *Neaid fragments*
*Fissidens sp.*

Habitat: Type 1, Backwater in Stream; Type 2, Delta Top; or Type 7, Lake Margin. The lithology and topography of the surrounding area suggest that stagnant ice of the Burnsted maximum lay buried and that in the area of this site was over-ridden by an advance of the Streeter ice. This suggests that the influx of glacier ice continued well after the beginning of a warm phase of the climatic cycle.

**Geochronology:** Moloid shells from this site were dated by the Washington, D.C., laboratory of the U. S. Geological Survey (N-974) at 11,450 ± 310 years before present (Rubin, personal communication to Wilson N. Laird). This date, coming from material which appears to have been disturbed by the ice of the Streeter advance, may suggest a maximum date for the Streeter advance of approximately
11,650 C$^{14}$ years. This may be an extremely local situation, however, and not reflect the general advance of the Streeter ice.

I. Lemanthal Site:- This site is located in a road cut in the SE$^{4}$
sec. 16, T. 132 N., R. 69 W. The exposure consists of broadly
folded, bedded lake silts and clays.

The sediments are collapsed lake clays and silts which are
a part of the deposits of Glacial Lake Lehr. The plain of Glacial
Lake Lehr is composed of lake silts and clays which cover approxi-
mately 40 square miles in north central McIntosh County and
south-central Logan County. This large plain forms the highest
topography in the area, rising like a butte amid the collapsed
till and outwash sediments. The presence of stagnant ice sheets
under and around the deposits is indicated by the fact that all
but three to four square miles at the center of the plain is
underlain by collapsed lake beds. Moreover the perimeter of the
plain is bordered by outward sloping ice-contact faces. The total
lack of drainage development in the Coteau district precludes the
idea that these outward sloping faces are erosional in origin.
The fauna is a thermoclinesm, the shells being fragmented and
disarticulated. One irregular pearl about 1 inch in diameter was
found at this site.

Fauna:-

Paleocupids: Leposilus radiata silicoides

Habitat:- Type 6, Shallow Lake.

J. Honey Cat Slough Site:- Located in a steep bank on the south side
of the slough from which it takes its name, this site is in the
NW$^{4}$, sec. 14, T. 132 N., R. 69 W. Figure 12 shows the lithology
Fig. 12. LITHOLOGY AND VERTICAL DISTRIBUTION OF MOLLUSCS IN SIENIC CAT.""
ROUGH SITE (J) N.W. CORN. 14, T. 132 N., R. 69 W., Bolsterh County, North Dakota.
of the exposure. The entire sequence is composed of beds of sands, lake silts and clays. An unconformity separates the beds of the upper 8 feet from the lower beds which are unfossiliferous and strongly contorted. An auger sample taken approximately 150 yards north of the site in the bottom of the present day slough contained 1/4 foot of decayed vegetable matter with shells of Ancora truncata, Lymatia philippus, Schneiira sp., and Gyraulus sp.; 1 foot of buff, unfossiliferous lake silts and clays resembling those in the base of the site; overlying at least 2½ feet of pebbly outwash. The present slough depression is a large kettle hole.

Fauna:-

Gastropods:  
Valvata trigonata  
Ampicola limosa  
Furca sp.  
Hellicoma granulatum  
Gyraulus sowerbyi  
Gyraulus sp.  
Fusinus fusiformis  
Arniacris arctica  
Haisa fragilis  
Fusinus sp.

Pelecypods:  

Habitat:- Type 6, Shallow Lake. The fauna represents a biocenose. The sterile lower beds which lie below the unconformity probably represent deposition during the time, after stagnation of the ice, before the drift insulated the bodies of water and the drainage channels sufficiently to permit turbidity to be reduced and solar elevation of the water temperature to occur. Thus there are two habitats represented in this site. The lower one was a cold, probably turbid lake which received melt water from supraglacial streams which were in contact with the ice. The upper 8 feet represent a permanent seasonally temperate body of water.
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<th>LITHOLOGY</th>
<th>FAUNA</th>
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<tr>
<td>Surface</td>
<td>Dark brown soil, sandy w/ pebbles.</td>
<td>3 &amp; 17.</td>
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<tr>
<td>1 ft</td>
<td>Medium sand to Medium gravel. No fossils.</td>
<td>17.</td>
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<tr>
<td>2 ft</td>
<td>Marlly clay w/ peat at top.</td>
<td>2, 3, 4, 7, 11, &amp; 17.</td>
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<tr>
<td>3 ft</td>
<td>Limy, medium sand. No fossils. Marl w/ peat.</td>
<td>3.</td>
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<tr>
<td>4 ft</td>
<td>Marl w/ root concretions.</td>
<td>2.</td>
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<tr>
<td>5 ft</td>
<td>Marl w/ silt at top. Very fine silt w/ root concretions.</td>
<td>17.</td>
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<tr>
<td>6 ft</td>
<td>Fine-medium sand. Medium to coarse sand.</td>
<td>17.</td>
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<tr>
<td>6 ft 4 in</td>
<td>Olive-gray silt.</td>
<td>4, 6, &amp; 17.</td>
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**Fig. 13. LITHOLOGY AND VERTICAL DISTRIBUTION OF MOLLUSKS IN ROSENTHAL SITE 1 (L) NE4 sec. 36, T. 131 N., R. 68 W., McIntosh County, North Dakota.**

**KEY TO THE MOLLUSCAN FAUNA**

- 2. Pisidium sp.
- 3. Valvata tricarinata
- 4. Amnicola limax
- 6. Hellisma anops
- 7. Gyraulus parvus
- 11. Ancylus granulatus
- 17. Mollad fragments.
streeter moraine.

**Fauna:**

- Gastropods: 
  - Valvata trigonata
  - Valvata lundel
  - Valvata sp.
  - Amnicola limosa
  - Amnicola sp.
  - Helicoma anseres
  - Gyranus parvus

- Paleonpods: 
  - Anomopoda ornata
  - Placidium sp.
  - Mailed prisms and fragments

**Habitat:** The peat layer and the marl layer represent Type 3, Delta Top or Type 6, Shallow Lake. The balance of the sediments represents a habitat higher in the drainage and therefore best fit habitat Type 4, Delta Front.

**Hessenthal Site 2:** This site is located in the NE sec. 34, T. 131 N., R. 66 W. Lake silts, clays, and outwash comprise the lithology of this site (see Fig. 14). The marl bed which contains most of the fossils, dips 9.5° to the north. This bed can be traced across the entire one-half section and appears to be distorted but no exposure exists where folds can be clearly seen. Like Hessenthal site 1 the sediments were deposited in a high level lake behind the Streeter moraine. Except for being jet down, the fossils were all untransported and are a neocenozoic.

**Fauna:**

- Gastropods: 
  - Valvata trigonata
  - Valvata lundel
  - Amnicola limosa
  - Amnicola sp.
  - Helicoma anseres
  - Gyranus parvus
  - Fumericus ornata
  - Lemna limosa

- Paleonpods: 
  - Anomopoda ornata
  - Placidium sp.
  - Mailed prisms and fragments

**Habitat:** Type 6, Shallow Lake.
Fig. 14. THE LITHOLOGY AND VERTICAL DISTRIBUTION OF MOLLUSKS IN ROSENTHAL SITE 2 (M) NO. 5 SEC. 34, T. 131 N., R. 68 W., Mcintosh County, North Dakota.
N. *Rosenthal site 3:* This site is located in the SE 4 sec. 25.

T. 131 N., R. 60 W. Lake clays, silts, and marls in a road cut 3\frac{1}{2} feet below the crest of a small hill comprise the site. The sediments are probably related to those encountered at Rosenthal sites 1 and 2.

**Fauna:**

- **Gastropods:**
  - *Valvata tricarinata*
  - *Amnicola limosa*
  - *Helix trivoluta*
  - *Syringus fervus*
  - *Syringus sp.*
  - *Pseudana anuranus*
  - *Lymania humilla*
  - *Physis sp.*

- **Pelecypods:**
  - *Ancodonta grandis*
  - *Lampilla radiata silicosidea*
  - *Placidium sp.*

**Habitat:** Type 2, Shallow Lake.

O. *Rosenthal site 4:* This site is located in the NE 4 sec. 27.

T. 131 N., R. 60 W. Marl in distorted lake clays and silts comprise the site.

**Fauna:**

- **Gastropods:**
  - *Valvata tricarinata*
  - *Amnicola limosa*
  - *Syringus fervus*
  - *Lymania humilla*
  - *Physis sp.*

- **Pelecypods:**
  - *Placidium sp.*

**Habitat:** Type 2, Shallow Lake.

P. *Rosenthal site 5:* This site is located in the NE 4 sec. 6, T. 131 N., R. 60 W. An undetermined thickness of sand underlying 1\frac{1}{2} feet of outwash gravel contains a few fossil mollusks. They all appear to have been transported.

**Fauna:**

- **Gastropods:**
  - *Valvata tricarinata*
  - *Amnicola sp.*
  - *Syringus fervus*

- **Pelecypods:**
  - *Ranid fragments*

**Habitat:** Type 2, Stream.
Q. Antelope site 1: This site is located in the NW\(^4\) sec. 30, T. 131 N., R. 67 W. Nonstratified to poorly stratified lake sediments in a 4 by 20 foot road cut comprise this site. A light brown fossiliferous layer overlies a darker brown unfossiliferous part of the exposure.

**Fossil:**
- **Gastropods:** *Valvata triseriata*  
  *Valvata decipiens*  
  *Assilina linearis*  
  *Granulina marina*  
  *Granulina sp.*  
  *Lychnia sp.*  
  *Prenestina sp.*  
  *Helisoma americanum*  
  *Melanoides tuberculata*

**Habitat:** Type 6, Shallow Lake.

R. Antelope site 2: This site is located in the NW\(^4\) sec. 16, T. 131 N., R. 67 W. The exposure consists of about 4 feet of p possibly outwash above 1 to 1½ inches of medium grained sand, above 1 to 1½ inches of yellow fossiliferous marl, above at least 2½ feet of lake clays and silts.

**Fossil:**
- **Gastropods:** *Valvata sp.*  
  *Granulina sp.*  
  *Prenestina sp.*  
  *Assilina virgata*  
  *Physa sp.*  
  *Pisidium sp.*

**Habitat:** Type 6, Shallow Lake.

S. New Farm site: The New Farm site is located in a road cut 0.2 miles north of the SE corner sec. 36, T. 130 N., R. 66 W., about 11.5 miles E. of Ashley. Thin bedded collapsed outwash sand and gravels contain the fossils. This site has produced the most abundant and varied fauna of Pleistocene mollusks of any so far studied in North Dakota. Most of the unids were found as articulated valves in living positions. A lithologic column is shown on Figure 15.

The fauna is a nearcoastal which inhabited an environment such
Fig. 15. THE LITHOLOGY AND VERTICAL DISTRIBUTION OF MOLLUSKS IN NUE FARM SITE (S) SE1/4, sec. 36, T. 130 N., R. 68 W., McIntosh County, North Dakota.
like that of the Cleveland site (A). Some postmortem concentration of the gastropods may have occurred, but the naied population was certainly not transported any significant distance. *Lamellia stigmatica* and the *Helicops* species probably occupied micro-habitats peripheral to the Lotia-lociata environment of the naieds.

**Fausae:-**

Gastropods:

*Valvata prarariata*
*Valvata loyisi*
*Ampicola* sp.
*L. limax*
*Lamellia stigmatica*
*L. humilis*
*Lamellia* sp.
*Phryn* sp.
*Helicops conspicuus*
*L. acosta*
*Syringa evanescens*
*Syringa* sp.
*Propermannia exalata*
*Amadycus cristus*
*Peristia* sp.

**Pelecypods:**

*Ammodonta grandis*
*Lamellia silicoides*
*Sphenina* sp.
*Pleistea* sp.
*Naied fragments*

**Habitat:-** Type 4, Delta Front.

**Geochronology:-** *Lamellia radiata silicoides* shells from this site were dated by the Washington, D.C., laboratory of the U. S. Geological Survey as having lived 9,620 - 350 C\(^14\) years before present (U.S.G.S. Sample number W-1149, Rubin personal communication to Wilson H. Laird).

**Loca site:**- This site is located in the SE\(_4\) SE\(_4\) sec. 34, T. 120 N., R. 60 W., McIntosh County, in a field approximately 12 feet N. of the road and 330 feet north of the S.E. corner of the section. A gravel body shows through the soil as an elongate sinuous band extending across the field in a general direction of N. 30\(^\circ\) E.
Snails were observed in this gravel and in the sandy soil adjacent to it. Lake clays with faint bedding still discernible were encountered at 24 feet depth. The fauna here reported came from these lake clays. Iowa site 1 is grouped with Iowa site 2 because of geographic proximity only.

**Families:** Gastropods:  
- Valvata tricarinata
- Ampelina limna
- Helciona aurata
- Gyraulus concavus
- Gyraulus sp.
- Placuna placenta
- Lymnaea humilla

**Habitat:** Type 2, Stream or Type 3, Delta Top.

U. Iowa site 2: Iowa site 2 is located in 5 NW 4, sec. 25, T. 130 N., R. 66 W., McIntosh County. The fossils occur in lake silts which exhibit poor or no bedding. This site may well be associated with the Iowa 1 and New Farm sites.

**Families:** Gastropods:  
- Valvata tricarinata
- Ampelina limna
- Lymnaea cf. L. humilla
- Gyraulus sp.
- Placuna placenta

**Habitat:** Type 6, Shallow Lake.

**Lamoure County**

V. Fedell Farm Site: This site is located 12 feet below the surface of an intermittent slough depression in the NW 4, sec. 14, T. 135 N., R. 66 W. Mr. Robert Fedell, owner of the land, discovered wood and associated shellfish shells in a post hole at approximately 12 feet depth while trying to dig a watering hole for his stock. I visited this site in April of 1963, but was unable to view the excavation because it was under water. Fortunately Mr. Fedell had saved
Fig. 16. INDEX MAP OF LA MOURE COUNTY, NORTH DAKOTA, SHOWING THE LOCATION OF THE PODELL FARM SITE.
samples of the wood and peat and the fauna reported below was taken from these samples. The situation which he describes appears to be very much like that described by Neir (1958, p. 108-114). The wood was identified as tamarack according to Mr. Elmer L. Worthington, Woodland Consultant, U. S. Department of Agriculture, Soils Conservation Service, Mandan, North Dakota (personal communication to Frank Schulte, Juf, North Dakota).

**Fossils:  Gastropods:**
- *Melissops trivialis*
- *Lymnaea palustris*
- *Lymnaea oblonga*
- *Lymnaea stagnalis*
- *Pomacea canaliculata*
- *Pyxna sp.*
- *Cypraeidae sp.*
- *Cypraeidae sp.*
- *Amhidry ariata*

**Habitat:** Type 6, Shallow Lake or Type 7, Lake Margin.

**Burleigh County**

The following sites were discovered and collected by D. E. Hansen, geologist on the staff of the North Dakota Geological Survey. I am responsible for the identification of the fossils and any conclusions drawn from them.

**N. Billingsmore Farm Site:** This site is located in the NW, sec. 12, T. 144 N., R. 75 W. The single fossil recovered was contained in silty marl taken from dead-ice marine of the Barred Oak Drift.

**Fauna:**
- **Gastropods:**
- *Cypraeidae sp.*
- *Cypraeidae sp.*
- *Cypraeidae sp.*

**Habitat:** Indeterminate. The marl and silt suggest a well oxygenated pond. Two occurrences of mollusc fossils are insufficient to provide a basis for conclusions other than that seasonally
Fig. 17. INDEX MAP OF BURLEIGH COUNTY, NORTH DAKOTA, SHOWING LOCATIONS OF THE FOSSILIFEROUS SITES.
temperate water was present at one time.

I. Field Farm site:—This site is located in the NE Sec. 17, T. 144 N., R. 76 W. It is in stagnation features of the Burnstad Drift.

**Fonna:**

- Gastropods:
  - *Valvata trigoniana*
  - *Amnicola limosa*
  - *Lymnaea annulus*
  - *Ceratula cornuta*
  - *Pisidium sp.*

**Habitat:**—Type 6, Shallow Lake.

II. Plewen Lake site:—This site is located in NW Sec. 17, T. 144 N., R. 76 W., in collapsed outwash in front of the Streator terrace of the Burnstad Drift.

**Fonna:**

- Gastropods:
  - *Valvata trigoniana*
  - *Amnicola limosa*
  - *Lymnaea annulus*
  - *Ceratula cornuta*
  - *Pisidium sp.*

**Habitat:**—Type 2, Stream.

III. Muller Farm site:—This site is located in the NE Sec. 14, T. 144 N., R. 76 W., 0.25 miles west of N.E. section corner. The fossils were enclosed in slits from the Burnstad Drift.

**Fonna:**

- Gastropods:
  - *Valvata trigoniana*
  - *Amnicola limosa*
  - *Lymnaea sp.*
  - *Ceratula cornuta*
  - *Pisidium sp.*

**Habitat:**—Type 6, Shallow Lake.

AA. Muller Farm site 2:—This site is located 0.25 miles south of the section corner of NE Sec. 14, T. 144 N., R. 76 W., in collapsed
outwash sediments of the Burnstad Drift.

**Fauna:**

**Gastropods:**

- Valvata tricarinata
- Amnicola limosa
- Lymnaea sp.
- Helisoma anceps
- Gyraulus netras
- Gyraulus sp.
- Anisus arctica
- Psiloglossa arctica

**Pelocypods:**

- Pisidium sp.
- Molluscs (fragments probably of Lampsilis radiata silicoides)

**Habitat:** Type 6, Shallow Lake. Although the aquatic pulmonates are very numerous, V. tricarinata forms an important part of the fauna. Thus permanent water was undoubtedly present throughout the time that the fauna lived. Vegetation, both marginal and aquatic, was probably present and the waters were temperate during the warm season.

**AB. Peatloch Farm site:** This site is located in the NE 3/4 sec. 22, T. 144 N., R. 76 W., 0.6 miles west of Highway 14 in collapsed outwash in front of the Strover Moraine of the Burnstad Drift.

**Fauna:**

**Gastropods:**

- Valvata tricarinata
- Amnicola limosa
- Lymnaea sp.
- Helisoma anceps
- Gyraulus netras
- Gyraulus sp.

**Habitat:** Type 6, Shallow Lake.

**AC. Peatloch Farm site:** This site is located 0.6 miles south of the section corner in the NE 3/4 of sec. 11, T. 144 N., R. 77 W., in dead-ice moraine of the Burnstad Drift.

**Fauna:**

**Gastropods:**

- Valvata tricarinata
- Amnicola limosa
- Lymnaea sp.
- Helisoma anceps
- Gyraulus netras
- Gyraulus sp.

**Pelocypods:**

- Pisidium sp.
Habitat: Type 6, Shallow Lake.

AD. Painted Rocks site: This site is located 0.7 miles east of the NE cor. sec. 12, T. 144 N., R. 79 W., in dead-ice moraine of the Burnsted Drift.

Fossils:

Pelocypods:
Echiura:

Habitat: Type 6, Shallow Lake.

AE. Pelican Lake site: This site is located in the NE/4 sec. 13, T. 144 N., R. 77 W., in marl on the edge of a kettle in dead-ice moraine.

Fossils:
Gastropods: Valvata tricornata, Gyraulus sp.

Pelocypods: Pseudosididae sp.

Habitat: Type 6, Shallow Lake. Marl suggests standing, clear, permanent water bodies. The fauna although it is small and simple supports this idea.

AF. Burtner Farm site: This site is located 0.5 miles south of NE cor. sec. 19, T. 143 N., R. 75 W., in dead-ice moraine of the Burnsted Drift.

Fossils:

Pelocypods: Pseudosididae sp.

Habitat: Type 6, Shallow Lake.
Fig. 16. INDEX MAP OF SHERIDAN COUNTY, NORTH DAKOTA, SHOWING LOCATIONS OF THE FOSSILIFEROUS SITES.
Sheridan County

The following sites were discovered and collected by M. R. Sherrod, graduate student at the University of North Dakota and Temporary Geologist for the North Dakota Geological Survey during the summer of 1962. I am responsible for the identification of the fossils and any conclusions drawn from them.

Ag. Teacher Farm Site:—This site is located 0.4 miles south of NE cor. sec. 13, T. 148 N., R. 76 W. The site is composed of lake sediments, mostly clay sized, at the east edge of the Missouri Coteau district. No lake outline is visible so presumably those sediments are collapsed.

**Pucca:**  Gastropods:  *Gyraulus sp.*  *Valvata trigeriana*

**Habitat:**—The sediments suggest Type 6, Shallow Lake, or Type 3, Deep Lake. The fauna is too small to offer information other than the presence of permanent, clear water in the area.

Al. Nuff Farm Site:—This site is located 0.6 miles west of SE cor. sec. 19, T. 148 N., R. 77 W. A single fragmentary gastropod was found in a well defined, ½ mile diameter body of collapsed lake sediments surrounded by high-relief dead ice moraine.

**Pucca:**  Gastropod:  One fragment

**Habitat:**—Type 6, Shallow Lake. The geology of the area suggests a freshwater pond in an ice basin. The fauna is not significant to reconstruct the ecology at the site, save to indicate conditions, somewhere in the supraglacial drainage system, which could support mollusks.

Al. Pecosita Site:—This site is located 0.2 miles south and 0.2 miles
east of NE cor. sec. 29, T. 147 N., R. 78 W. The sediments were collected from a tailings pile beside a cattle watering dugout. The dugout is in a depression between high, well-defined ridges near the summit of the Lincoln Valley moraine in the Prophets Mountains. The mollusks were taken from rhythmically bedded, clayey lake sediments. Recent sloughs occupy most of the depressions in the area.

**Fauna:**

<table>
<thead>
<tr>
<th>Gastropods:</th>
<th>Helicininae</th>
<th><em>Cyrnula cornus</em></th>
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<tbody>
<tr>
<td></td>
<td><em>Anasim persia</em></td>
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<tr>
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<td><em>Lumacea humilis</em></td>
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<td><em>Lumacea</em>, sp. cf. <em>L. salina</em></td>
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</table>

**Pelecypods:** *Pseudidium* spp.

**Habitat:** Type 6, Shallow Lake.

**Remarks:** The sediments also contain excellently preserved fossil fish of the families Cottaceidae (suckers) and Cyprinidae (dues and chub). The molluscan fauna lacks brachiote forms and may be Recent in age. The site is receiving further study by Sherrod (1963). The fish are being studied by Mr. Robert Miller and Teruya Uyeno of the University of Michigan. The latter kindly supplied the tentative identifications. Their age (i.e., early Recent or Wisconsinan) has not yet been established.

**Shredder Farm site:** This site is located 0.4 miles north of SE cor. sec. 34, T. 147 N., R. 77 W. The sediments which contain the fossil mollusks are in deep ice moraine at the edge of a collapsed outwash plain.

**Fauna:**

<table>
<thead>
<tr>
<th>Gastropods:</th>
<th><em>Valvata tricornata</em></th>
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<tbody>
<tr>
<td></td>
<td><em>T. lenticularis</em></td>
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<tr>
<td></td>
<td><em>Cyrnula cornus</em></td>
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<tr>
<td></td>
<td><em>Cyrnula</em> sp.</td>
</tr>
<tr>
<td></td>
<td><em>Prochiton exustus</em></td>
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</tbody>
</table>

**Pelecypods:** *Pseudidium* spp.
Habitat: Type 2, Stream, or Type 6, Shallow Lake.

**AK. Silverman Farm site:** This site is located 0.4 miles north of NW cor. sec. 26, T. 147 N., R. 77 W. The fossiliferous sediments are at the edge of a body of collapsed outwash sediments.

*Fama:* Gastropods: *Valvata triraridita*

**Habitat:** Type 2, Stream.

**AK. McClusky site:** This site is located 0.2 miles south of NW cor. sec. 31, T. 147 N., R. 77 W. The sediments containing the fossil mollusks are clay and are a part of a body of dead ice moraine. No definable lake outline was observed by Mr. Shaved at this site.

*Fama:* Gastropods: *Valvata triraridita*
Felecypods: *Fusulina sp.*

**Habitat:** Type 1, Backwater. Type 4, Delta Front. Type 5, Deep Lake, or Type 6, Shallow Lake.

**AK. Stock Farm site:** This site is located 0.5 miles south of NW cor. sec. 15, T. 146 N., R. 77 W. The sediments are in dead ice moraine and the fossils are contained in clayey silt. No definable outline of a body of lake sediments was observed by Mr. Shaved.

*Fama:* Gastropods: *Amnicola cf. A. limata* *Valvata triraridita* *Fusulina spp.*
Felecypods: *Fusulina sp.*

**Habitate:** Type 6, Shallow Lake.

**Divide County**

Mr. Hansen discovered and collected a fossiliferous site in Divide County. The site described below is interesting as it shows the geographic range in North Dakota of the fossiliferous ice-contact
Fig. 19. INDEX MAP OF DIVIDE COUNTY, NORTH DAKOTA, SHOWING LOCATION OF THE ROLLIE PAMP SITE.
Saves associated with the Missouri Coteau. Divide County is in the extreme northwestern corner of North Dakota. While not yet fully studied, the Missouri Coteau is known to maintain its character of high relief and low relief dead-ice moraine from Dickey County to the southeast to Divide County in the northwest and it is probable that the conditions postulated from the examination of the sediments and fossils reported here from the southern part of the Coteau are typical of the entire Missouri Coteau district.

Ann. Rosale Farm site: This site is located in the 5th Meridian W.D. sec. 34, T. 160 N., R. 96 W., very near the Divide-Williams County boundary, about 25 miles south of the Canadian boundary. The sample was collected from a road-cut near the boundary of collapsed lake and collapsed cutmeh sediment. The sediment from which samples were taken is 2 feet thick. A thin surface soil zone is developed on the top of this body of sediments and the unit overlies a medium-grained sand unit of unknown thickness, but small areal extent. The drift is of either late Wisconsin or early Recent age and is as yet unnamed.

Genus: Gastropods: Valvata tridentata

Lymnaea humilis

Gyrinella carinata

Fremingtonia mucronata

Helisoma trivolis

Rhytidina sp.

Pelecypods: Valvata tridentata

Lymnaea humilis

Gyrinella carinata

Fremingtonia mucronata

Helisoma trivolis

Rhytidina sp.

Habitat: Type 3, Wulita Top; Type 4, Wulita Front; or Type 6, Shallow Lake.
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</table>

**No. species/site**

- Gastria aspa sp.
- Sarcinaria apetala
- Perichaena sp.
- Helisoma undulatum Helisoma undulatum
- Melampus pringlei
- Ariophanta
- Gyrandothella
- Cymatella
e
- Lymnaea palustris
- Lymnaea stagnalis
- Pseudana
- Seminatibarca
- Seminatibarca
- Voluta nassa
- Voluta gigantea
- Voluta trunculata
- Dr. Dennis Smith
- Piddockia
- Euphilus spp.
- Euphilus spp.
- Bivalvia multiple
- Bivalvia multiple
CONCLUSIONS

The conclusions which logically issue from this type of study are
of two types: first, the organisms are presumptive evidence for ecologic
conditions; and secondly, the conditions inferred in one provide the
basis for secondary conclusions with respect to evaluations of geologic
time and the correlation of sediments.

The reconnaissance nature of this investigation precludes all but
the grossest generalities. To postulate details of the aquatic environ-
ment and its chemical composition and physical condition is an over-
extension of our knowledge of the ecologic limits of the various species
of mollusks. General climatic conditions can be suggested and compari-
sons with regions currently supporting similar molluscan communities
can be safely made.

From rather limited studies of the Recent molluscan fauna of the
Missouri Coteau (Tubill and Laird, 1963) a slight, but significant
difference in the species composition appears to exist. The Recent
faunas are strongly dominated by the pulmonate genera Physa, Lymnaea
and Gyraulus, whereas the Wisconsinan faunas were strongly dominated
by the prosobranchiate genera Valvina and Ampicula. This suggests the
greater permanency of water bodies during Wisconsinan time. A more
humid climate would be the logical cause for greater permanency of
aquatic environments than now exists. All species found in the fossil
faunas are found in bodies of water in the Coteau Slope district which
adjoins the Missouri Coteau district on the west and which forms the
eastern drainage slope of the Missouri River in the area. The opercula-
tates are present in the Coteau Slope, but do not dominate there.
Thus the faunal differences are assessable only by an evaluation of
molluscan communities rather than by species composition differences caused by local extermination or actual evolutionary extinction.

The nearest area known to support molluscan faunas essentially identical to the Wisconsinan faunas is northwestern Minnesota (Tuthill, Clayton, and Laird, in press). The climatic differences between this part of Minnesota and the Missouri Coteau district in North Dakota are very slight. The most significant apparent difference seems to be that the Minnesota locality is in an area having a surplus with respect to precipitation-evapotranspiration relationships, whereas the Missouri Coteau is an area of deficiency (Thorntumite, 1948). This difference, slight though it be, has far reaching effects on ecologic conditions in the two areas. The chemistry of the lakes in the two areas responds very directly to this ratio of precipitation vs. evapotranspiration.

The geology of the Missouri Coteau clearly indicates a dynamic situation where thick drift cover conserved buried ice blocks for long periods of time. Collapse of sediments, draining of ponds and lakes and deflection of river and stream courses would be expected to occur with greater frequency than under more usual conditions. The amount of dynamic drainage change could not have been very great, however, because the dominance of fossil molluscan communities by gill-bearing operculates suggests clear water. That mollusk-supporting bodies of clear water could endure in the terminal ice of a stagnant glacier has been proved by studies I am conducting in the area of the Martin River Glacier, Alaska. Although most of the glacier melt water there is carried away by turbid streams and many polar lakes of turbid water exist, a significant number of clear-water, temperate lakes exist
The reader of pressurizable containers: the actual gamma and alpha phase, this should be noted that pressurization of the pressurized liquid or gas in the container is conducted in the proportion process of the pressurized liquid or gas atmosphere, no excessive additional pressure can be induced from the container.

of pressurizable containers of the pressurized

western hemisphere, but more especially the increased decrease the occurrence.

Recent reports concerning accidents to the same company (X, Y, Z, etc.)

there is no doubt that the conditions of the metal were not the

from the pressurized container of the metal or gaseous container cannot be interrupted

in the metal or the pressurized container atmosphere cannot be interrupted.

The actual amount of oxygen, carbon dioxide, nitrogen, etc. discharged,

or the faulty because of occurrence of pressurized container.

selection in constitution of liquid, gas, and pressurized

as well as problems of depressurization, depressurization, and depressurization

with. To escape these special conditions of an in-core reactor,

which have lead to in-reactor accidents, represent qualitative change.

or a solid containment would be required to manage these containment

needed, as mentioned above the cases for我想 to change in a limited

therefore, a containment should be the cases for the pressurized

storing been a consideration of the pressurized containment.

the process of depressurization. The material to depressurization

result of depressurization on the material to depressurization.

The phenomena through the pressurized containment.

The phenomena through the pressurized containment.

The phenomena through the pressurized containment.

The phenomena through the pressurized containment.

Introduction
mentioned may have been replaced by others which would complete the community equally well.

The snails, as previously mentioned, require fish of the families Forcidae or Centrarchidae in their planktivorous stage. Many of the interiors of the shells of *Amadeus grandis* exhibit small (about 0.3mm high and 0.75mm dia.) pearl blisters. These are similar to the blisters formed over the eggs of necto in the genus *Palola* Halicama 1843 in living specimens. *Lamellidina radiata* *alligadina* and probably species of *Amadeus* too, frequently are hosts for the trematodes *Catyliopsis lameli* and *Amidocystis spongiosa*. The mucous coat of the mantle frequently contains various species of *Vorticella* as well as the protozoa *Conchoecithus auritus* and *S. amadei*. The oligochaetae were *Chenoceras limax* is frequently found in snail valves where it feeds on the various parasites. Normal predators of snails today are muskrats, raccoons, mink, water fowl, turtles and sea. It is conceivable that some or all of these were present during late Wisconsinian time. Aquatic as well as marginal vegetation was present in some form as a basis of the diet of the clams.

The gastropod fauna suggests the possible presence of the plant genera *Potamogeton*, *Hydrocharis*, *Salix*, *Castanea*, *Ammia*, *Syrrhopilum*, *Liliana*, *Truda*, *Clepsis*, *Sedereus*, and *Vanherbe*, if present floral associates of the various species of snails in the mid-continent are also typical for late Wisconsinian time.

Chronology, the constant concern of the paleontologist, is complicated by the fact that none of the species of the fossil assemblage is extinct nor even locally exterminated. The community, as discussed above, may eventually prove to be useful for age determinations. At
present the sediments in the Missouri Coteau district which contain
molluscan faunas dominated by the genera *Valvata* and *Amnicola* and are
tentatively used to assign it a Wisconsinan age.

Actually the snails are providing the most information for assess-
ments of age. They have been used for the determination of radiocarbon
age of five sites (Guschenicht Farm site - M-956, 9,000-300; Nue Farm
site - M-1149, 9,630-330; Schaefer Farm site - M-956, 9,870-390;
Cleveland site - M-956, 11,070-300; and Hufnagelstall site - M-974,
11,650-310, see Fig. 20). These dates are too few in number to provide
the basis for a formal time-classification for use in North Dakota.
They do suggest a pattern of events and are intimately associated with
paleoecologic interpretations. Fig. 20 shows the chronologic relation-
ships of these five sites graphically. A modification of a portion of
Frye and Willman's (1960) classification, proposed for the Michigan
lobe in Illinois is shown on Fig. 2. As this classification is based
on radiocarbon time, rather than lithologic extensions, I regard it as
being at least germane if not of enduring value in the area studied.

If the distribution of these five dates proves to be a reflection
of the situation which actually exists, mollusks may have lived in the
aquatic environments of the Missouri Coteau during the latter part of
Turonian time, been locally exterminated (possibly by some aspect of
climate) during early Valderan time and then returned during a latter
part of that time. The drift of the Missouri Coteau in its entirety
resulted from sedimentation of material transported into the area
during Woodfordian and/or Turonian time. Both the Cleveland and the
Hufnagelstall sites (the oldest) are inside the Streeter Moraine of
the Buried Drift. The existence of younger faunas outside the Streeter
Fig. 20. DISTRIBUTION OF RADIOCARBON DATES FROM MOLLUSK SHELLS IN RELATION TO THE LATE PLEISTOCENE TIME DIVISIONS.
the continuation of investigation to both the north and the south, on
these studies suggest the value of continuing the work and
of the meridian to the north. Possibly by using a method
meridian, could have indicated the reference points of the station.
the influence of one of the solstices which influence the

(CH. 16, Eq. 5.4)

Then these figures are advanced into London, County after 11.40 g
but must have formed part to the complete working of the instrument too.
the parallax for which is presented to the observer working.
formed during the passage of the sun which completed the position of
11.40 g to 11.60 g (the passage of 2º) The complete chart also could not have been
announced for the last date of the observer advance (7.4. 13.
represent the chart, the instrument is provided a more
and the departure and ordinate of the instrument at the also accurately
the observer in and motion of the observer working. If this is true,
the measurement of the instrument (11.60 g to 24.00 g) (Ch. 15, p. 66) means that
the observer advance would be that of the instrument (11.40 g.
the Straight going on the principle of the horizontal plane.
The observer from its location at the paracentric plane to
age of the paracentric (9.6. 13.) well after the second day of
after the second day of the paracentric (9.6. 13.)
fossil mollusks should eventually provide criteria for more reliable
correlation of glacial sediments than the techniques of lithologic
equivalency will allow, as well as possible details of late Pleistocene
climate.
DESCRIPTIVE PALEONTOLOGY

In this section a partial synonymy is given which is designed to indicate the concepts of the various species with which I believe the material from the Missouri Cretaceous district compares. I have not included original citations because I have not seen most of them. The purpose of this investigation is paleontologic and not primarily taxonomic. A brief description of the fossil material, including measurements of representative specimens, geologic age of the material described, and records of occurrence are also given. The records of occurrence are given by a letter which refers to the site and a number which is the catalogue number under which the specimen or specimens is curated in the University of North Dakota Department of Geology collection.

The following meanings are assigned to the terms; very small, small, medium, and large:

**Pelecypods:**
- Very small = less than ½ cm.
- Small = greater than ½ cm to 2 cm in greatest dimension.
- Medium = greater than 2 cm to 10 cm in greatest dimension.
- Large = greater than 10 cm in greatest dimension.

**Gastropods:**
- Very small = less than 2 mm in greatest dimension.
- Small = greater than 2 mm to 5 mm in greatest dimension.
- Medium = greater than 5 mm to 10 mm in greatest dimension.
- Large = greater than 10 mm in greatest dimension.

The descriptive terminology of Cox (1960, p. 104-126) is used for gastropods in this section.
Fig. 21. DIAGRAM OF SHELL ORIENTATIONS USED IN MEASURING OF SPECIMENS.
Systematic List Of Mollusca

Class PLECTOPHORA

Order EELABELLIDRANCHIA

Superfamily WALEAIDAE

Family UNIONIDAE

Arcestes granulosa Say, 1829.
Arcestes limnaei (Say), 1824.
Lampsis radiata sillonensis (Barnes), 1823.

Order TELEODESCHACA

Family SPHAERIDAE

Sphaerium sp.

Pleodiella sp.

Class GASTROPODA

Subclass STREPTONHUSA

Order MESOGASTROPODA

Superfamily VALVATACCA

Family VALVATIDAE

Valvata trisulcata (Say), 1817.
Valvata levuli Currier, 1868.

Superfamily RIESOACEA

Family HYDRIDIIDAE

Amnicola limana (Say), 1817.
Amnicola sp.

Subclass EUTHENUSA

Order BASDNMATOPHORA

Superfamily LYNNAEACEA

Family LYNNAEIDAE

Lymnaea palustris Müller, 1774.
Lymnaea uniflora (Say), 1822.
Lymnaea stagnalis (Linnaeus, 1758.

Superfamily ANCYLACEA

Family ANCYLIDAE

Peltina sp.

Family PLANORIDAE

Spiraletus caryi (Say), 1817.
Spiraletus sp.

Planorbus martinii (Say), 1821.

Ariocarpus triastra (Linnaeus), 1758.

Melanoides tuberculata (Say), 1821.
Melanoides tuberculata (Say), 1821.

Family PHYSIDAE

Physa sp.

Order STYLOMATOPHORA

Suborder ORNITHINITINA

Superfamily FOXILLIDACEA

Family FOXILLIDAE

Gastropoda sp.

Suborder BETHINITINA

Superfamily SUBCUNEACEA

Family SUBCUNEIDAE

Stenites awara (Say), 1824.
Anodonta grandis Say, 1829

Pl. 2 Fig. 1


Description of the fossil material:— Medium; relatively thin shelled; produced in the area of the beaks; rounded anterior margin; length approximately twice height; posterior margin, usually broken, narrowing to a rounded point; beak with concentric double-leveled ridges; no teeth.

<table>
<thead>
<tr>
<th>UND #</th>
<th>Valve</th>
<th>Height (cm)</th>
<th>Length (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3207-1</td>
<td>Right</td>
<td>4.37</td>
<td>broken posterior</td>
</tr>
<tr>
<td>3207-2</td>
<td>Right</td>
<td>5.00</td>
<td>&quot;</td>
</tr>
<tr>
<td>3195</td>
<td>Left</td>
<td>4.77</td>
<td>&quot;</td>
</tr>
<tr>
<td>3205-1</td>
<td>Left</td>
<td>4.79</td>
<td>&quot;</td>
</tr>
<tr>
<td>3205-2</td>
<td>Left</td>
<td>3.30</td>
<td>&quot;</td>
</tr>
<tr>
<td>3205-3</td>
<td>Left</td>
<td>5.25</td>
<td>&quot;</td>
</tr>
<tr>
<td>3197</td>
<td>Left</td>
<td>3.84</td>
<td>&quot;</td>
</tr>
<tr>
<td>3212</td>
<td>Articulated</td>
<td>2.98</td>
<td>5.13</td>
</tr>
</tbody>
</table>

Occurrences:— A. 3222, 3522; L. occurs; M. 3391, 3392; N. 3317; S. 3195, 3197, 3201, 3207, 3212, 3214.

Solenia Age:— Late Wisconsinan.

Remarks:— Anodonta grandis is in conjunction with the other snails is important presumptive evidence for fish of the families Centrarchidae and Percidae, species of which serve as hosts for the gloschid of the clams. A. grandis feeds only on vegetable detritus (Novard, 1922, p. 63-69) thus suggesting abundant aquatic vegetation; the respiratory method (gills) of this species requires relatively clear water. During the first two years of this study a search for fossil remains of fish
in the Missouri Coteau sediments was fruitless, but Mr. M. E. Sherrod (1963) has found specimens of both of 2 fresh-water fish (see Prophets site AI) in collapsed lake sediments in Sheridan County.

**Aneodonta ferrugenciana** (Lee), 1834


**Description of fossil material:** Medium, thin shelled, elliptical (margins broken); beak sculpture of single-looped, concentric bars; without hinge teeth; beaks anterior and slightly prescine.

**Occurrence:** A. 3223.

**Geologic Age:** Late Wisconsinan.

**Remarks:** This species is differentiated (in the shell) from small **Aneodonta grandia** by the beak sculpture according to Baker (1926a, 177). In A. grandia the beak has concentric, raised loops or bars which have one or more deflection toward and away from the apex so as to form small apical "V" in each loop. **A. ferrugenciana** does not have these deflections and the loops are arranged concentrically. The shells assigned to this species were broken at the margins, but sufficient material was present to support the conclusion made from an examination of the beaks to permit a good degree of confidence in the identification.

**Lamellis Radiata Silicoides** (Barnes), 1825.

Pl. 2 Figs. 5-7

**Description of fossil material:** Medium to large, moderately thick shelled; elliptical, 1/3 times as long as high, smooth, female with angular posterior ventral margin and greatest height in posterior 1/3; beak sculpture of several fine wavy bars which loop apically at their ends; beaks anterior and slightly procumbent; two lateral teeth in left valve, one in right valve; pseudocardinal teeth ragged, left valve containing the larger. Growth-interruption lines regular and not strongly raised.

<table>
<thead>
<tr>
<th>UND #</th>
<th>Valve</th>
<th>Height (cm)</th>
<th>Length (cm)</th>
<th>Sex</th>
</tr>
</thead>
<tbody>
<tr>
<td>3279</td>
<td>Right</td>
<td>6.00</td>
<td>broken</td>
<td>Male</td>
</tr>
<tr>
<td>3279</td>
<td>Left</td>
<td>6.03</td>
<td>12.10</td>
<td>Male</td>
</tr>
<tr>
<td>3280</td>
<td>Right</td>
<td>5.51</td>
<td>8.45</td>
<td>Female</td>
</tr>
<tr>
<td>3196</td>
<td>Right</td>
<td>4.49</td>
<td>8.65</td>
<td>Male</td>
</tr>
<tr>
<td>3196</td>
<td>Left</td>
<td>4.50</td>
<td>broken</td>
<td>Male</td>
</tr>
<tr>
<td>3200</td>
<td>Right (art.)²</td>
<td>broken</td>
<td>10.43</td>
<td>Male</td>
</tr>
<tr>
<td>3200</td>
<td>Left (art.)</td>
<td>5.80</td>
<td>10.35</td>
<td>Male</td>
</tr>
<tr>
<td>3204-1</td>
<td>Left</td>
<td>4.03</td>
<td>broken</td>
<td>Female</td>
</tr>
<tr>
<td>3204-2</td>
<td>Left (art.)</td>
<td>5.14</td>
<td>posterior</td>
<td>Male</td>
</tr>
<tr>
<td>3204-2</td>
<td>Right (art.)</td>
<td>4.74</td>
<td>posterior</td>
<td>Male</td>
</tr>
<tr>
<td>3204-3</td>
<td>Right</td>
<td>4.56</td>
<td>8.45</td>
<td>Male</td>
</tr>
<tr>
<td>3204-4</td>
<td>Left</td>
<td>4.87</td>
<td>broken</td>
<td>Male</td>
</tr>
<tr>
<td>3204-5</td>
<td>Right</td>
<td>4.27</td>
<td>posterior</td>
<td>Female</td>
</tr>
<tr>
<td>3204-6</td>
<td>Right</td>
<td>5.13</td>
<td>9.15</td>
<td>Female</td>
</tr>
<tr>
<td>3204-7</td>
<td>Right</td>
<td>5.24</td>
<td>posterior</td>
<td>Female</td>
</tr>
<tr>
<td>3198</td>
<td>Right</td>
<td>3.98</td>
<td>broken</td>
<td>Male</td>
</tr>
<tr>
<td>3199-1</td>
<td>Right (art.)</td>
<td>4.53</td>
<td>7.63</td>
<td>Female</td>
</tr>
<tr>
<td>3199-1</td>
<td>Left (art.)</td>
<td>4.54</td>
<td>7.79</td>
<td>Female</td>
</tr>
<tr>
<td>3199-2</td>
<td>Left</td>
<td>4.46</td>
<td>7.90</td>
<td>Male</td>
</tr>
</tbody>
</table>

²The abbreviation art. means the valves were articulated and therefore measurements are slightly different than would be obtained from single valves.
3502  Left (art.)  4.33  0.16  Female
3502  Right   4.38  0.19  Female

Occurrences:  B. 3666, 3647; 1, 3215; H. 3210; S. 5, 3194, 3196, 3198, 3199, 3200, 3202, 3203, 3204, 3206, 3208, 3210, 3211, 3213, 3216, 3219, 3279, 3280, 3281, 3282, 3283.

Scolicia Age:  Late Wisconsin.

Remarks:  Shell fragments have been found at sites: A, C, E, H, J, K, N, P and X. It is possible that these fragments, often nothing more than prisms, are reworked from older sediments. It is more likely, however, that these fragments are from Pleistocene sediments, but the possibility that they are from Cretaceous marine pelecypods cannot be ignored.

_Sphaerium_ app.

_Fig. 2  Fig. 2_

Description of fossil material:  Small, thin-shelled, oval to triangulate, beaks central, anterior and posterior halves approximately symmetrical in external appearance, cardinal and lateral teeth present, prosslope of fine concentric ridges. Many shells have a raised apical portion of the valve which usually have concentric growth-interruption lines.

<table>
<thead>
<tr>
<th>UN</th>
<th>Height (cm)</th>
<th>Length (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3573-1</td>
<td>.64</td>
<td>.63</td>
</tr>
<tr>
<td>3573-2</td>
<td>.62</td>
<td>.60</td>
</tr>
<tr>
<td>3591</td>
<td>.94</td>
<td>1.26</td>
</tr>
<tr>
<td>3521-1</td>
<td>1.24</td>
<td>1.68</td>
</tr>
<tr>
<td>3521-2</td>
<td>1.25</td>
<td>1.67</td>
</tr>
</tbody>
</table>

Occurrences:  A. 3521; B. 3596; S. 3233, 3232, 3264, 3572, 3503; M. 3374; X. 3135; AD. 3179, 3183, 3167.
Geologic Age: Late Wisconsin.

Remarks: The purpose of this research was to assess the paleoecology of the Wisconsinan sediments of the Missouri Colossus. The taxonomy of the Sphaeroididae awaits major revision, therefore ecologic inferences based on species of this family are subject to great error. For this reason their occurrence has been noted, but they have not been thoroughly studied as yet.

Fieldium spp.

Pl. 1 Fig. 21

Description of fossil material:—Very small; approximately as high as long. Noponid valve not distinguishable in presereps; beaks eccentric with respect to a plane normal to the plane of commissure and parallel to the line of greatest height; lateral teeth present.

<table>
<thead>
<tr>
<th>UNO</th>
<th>Weight (cm)</th>
<th>Length (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3220-1</td>
<td>0.072</td>
<td>0.077</td>
</tr>
<tr>
<td>3220-2</td>
<td>0.072</td>
<td>0.077</td>
</tr>
<tr>
<td>3220-3</td>
<td>0.066</td>
<td>0.066</td>
</tr>
<tr>
<td>3220-4</td>
<td>0.063</td>
<td>0.070</td>
</tr>
<tr>
<td>3220-5</td>
<td>0.073</td>
<td>0.060</td>
</tr>
<tr>
<td>3220-6</td>
<td>0.076</td>
<td>0.060</td>
</tr>
<tr>
<td>3220-7</td>
<td>0.054</td>
<td>0.061</td>
</tr>
</tbody>
</table>

References: A. 3516; B. 3592, 3609, 3619, 3626, 3635, 3637, 3642; U. 1768; E. 3605; F. 1781; C. 3649, 3582; H. occurs; J. 3414, 3418, 3426; L. 3341, 3350; N. 3375, 3376, 3379, 3383; M. 3400; O. 3360, 3366; N. 3449; S. 3220, 3230, 3243, 3250, 3266. 3273, 3291, 3300, 3308, 3326, 3332, 3373; U. 3561; X. 3133; Z. 3140; AA. 3150; AC. 3151; AD. 3186; AE. 3162; AF. 3129, 3120; AL. 6154; AJ. 6166; AL. 6159; AM. 6172.

Geologic Age: Late Wisconsin.

Remarks: The state of the taxonomy of this group awaits major
revisions. As in the case of *Subborealis*, I have not attempted specific
assignment of *Plicatula* because they will not offer a satisfactory basis
for paleoecologic reconstruction until they can be confidently identified
and are widely collected.

*Valvata trivariata* (Say), 1817.

Pl. 1 Figs. 14, 16.

1) *Valvata trivariata* (Say). Walker, 1902, Nautilus, v. 15,
p. 121-122, fig. 1-4. Gall, 1905, Harriman Alaska Series,
Hist. Survey Bull. 70, pt. 1, p. 16, pl. 1, fig. 1-3. Frye
and Leonard, 1932, Kansas Geol. Survey Bull. 99, pl. 15,
fig. 4.

p. 16, pl. 1, fig. 4.

**Description of fossil material:** Small; about 3½ whorls; turbinate,
dextral, orthostrophic, carinate with 1, 2, or 3 carinae or nuncarinate.
Whorl profile circular, first two whorls involute, subsequent whorls
involute, suture at middle carina; nucleus without carinae or ornamenta-
tion, sunken below next whorl; surface shiny and with thread transverse
lines at former aperture positions; aperture circular, operculate,
without a callus; narrow indusibuliform umbilicus.

<table>
<thead>
<tr>
<th>Unit</th>
<th>No. of Whorls</th>
<th>Shell Height Diameter (mm)</th>
<th>Aperture Height Diameter (mm)</th>
<th>Umbilicus Diameter (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3284-1</td>
<td>3 1/2</td>
<td>3.0</td>
<td>2.1</td>
<td>0.9</td>
</tr>
<tr>
<td>3284-2</td>
<td>3 1/2</td>
<td>3.2</td>
<td>2.0</td>
<td>1.0</td>
</tr>
<tr>
<td>3284-3</td>
<td>3 1/2</td>
<td>3.0</td>
<td>1.9</td>
<td>1.0</td>
</tr>
<tr>
<td>3284-4</td>
<td>3 1/2</td>
<td>2.5</td>
<td>1.9</td>
<td>1.2</td>
</tr>
<tr>
<td>3284-5</td>
<td>3 3/4</td>
<td>3.4</td>
<td>2.2</td>
<td>1.1</td>
</tr>
<tr>
<td>3284-6</td>
<td>3 1/4</td>
<td>2.7</td>
<td>1.9</td>
<td>0.7</td>
</tr>
<tr>
<td>3284-7</td>
<td>2 3/4</td>
<td>1.7</td>
<td>1.2</td>
<td>0.5</td>
</tr>
<tr>
<td>3284-8</td>
<td>3 1/2</td>
<td>2.6</td>
<td>1.9</td>
<td>1.1</td>
</tr>
<tr>
<td>3284-9</td>
<td>3 1/2</td>
<td>2.4</td>
<td>1.0</td>
<td>0.8</td>
</tr>
<tr>
<td>3284-10</td>
<td>3 1/2</td>
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<td>0.8</td>
</tr>
<tr>
<td>3284-11</td>
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<td>2.0</td>
<td>1.4</td>
<td>0.6</td>
</tr>
<tr>
<td>Unit</td>
<td>No. of</td>
<td>Shell Height (mm)</td>
<td>Shell Diameter (mm)</td>
<td>Aperture Height (mm)</td>
</tr>
<tr>
<td>------</td>
<td>--------</td>
<td>-------------------</td>
<td>---------------------</td>
<td>---------------------</td>
</tr>
<tr>
<td>3555-1</td>
<td>3 1/2</td>
<td>3.7</td>
<td>4.7</td>
<td>2.3</td>
</tr>
<tr>
<td>3555-1</td>
<td>3 3/4</td>
<td>2.9</td>
<td>4.2</td>
<td>1.8</td>
</tr>
<tr>
<td>3555-2</td>
<td>3 3/4</td>
<td>3.6</td>
<td>4.3</td>
<td>1.8</td>
</tr>
<tr>
<td>3555-3</td>
<td>3 3/4</td>
<td>3.7</td>
<td>4.5</td>
<td>2.1</td>
</tr>
<tr>
<td>3555-4</td>
<td>3 1/2</td>
<td>2.7</td>
<td>3.6</td>
<td>1.8</td>
</tr>
</tbody>
</table>

**Orchidacea:** A. 3509; B. 3507, 3607, 3618, 3623, 3630, 3639, 3643; C. 1776, 3599; G. 1767; E. 3664; F. 1763; B. 3579, 3465; B. 3541; J. 3411, 3417, 3426, 3442; K. 3468; L. 3442, 3352; M. 3367, 3261, 3378; N. 3403; O. 3556, 3565; P. 3478; S. 3223, 3246, 3251, 3265, 3277, 3295; 3299, 3307, 3222, 3323, 3329, 3570; T. 3284; U. 3562; V. 3194; Y. 3173; S. 3139; AA. 3149; AB. 3166; AC. 3159; AD. 3185; AF. 3124, 3116; AG. 6157; AJ. 6168; AK. 6162; AL. 6160; AN. 6173.

**Geologic Age:** Late Wisconsinan.

**Valvata Lewisi** Carriére, 1868

Pl. 1 fig. 19


**Description of fossil material:** Small; about 3½ whorls; turbinate, dextral, orthostenoid, adovulate, without carinae, sutures impressed; surface with coarser transverse lines than in the corinate form of *V. triaxiata*; nucleus unornamented, rising above next whorl; aperture circular, opesiate, without a callus; moderately narrow umbilicus.
Remarks: This species is quite rare in the collections from the Eocene sediments of the Missouri Cotens and is not, therefore, a significant taxon in reconstructing the paleoecology of the sites where it is found.

*Annicola limana* (Say), 1817

Pl. 1 Figs. 18, 19


(2) *Annicola limana exarata* (Say). Baker, 1928, op. cit., p. 98, pl. 6, fig. 7 & 8.


(4) *Annicola limana superiorensis* Baker. Baker, 1928, op. cit., p. 101, pl. 6, fig. 9-11, pl. 7, fig. 22, 23.

(5) *Annicola leightonii* Baker. Baker, 1928, op. cit., p. 120, pl. 6, fig. 34-39.


Description of fossil material:— Small; 4½ whorls; conoideal, globular, orthostrophic, slightly involute; nucleus elevated above next whorl, smooth or minutely granular; surface with transverse thread costellae, finer and more widely spaced spiral lines; narrow umbilicus exposes only the last whorl; aperture cordate operculate.

<table>
<thead>
<tr>
<th>Unit</th>
<th>No. of Whorls</th>
<th>Shell Height Diameter (mm)</th>
<th>Shell Diameter (mm)</th>
<th>Aperture Height Diameter (mm)</th>
<th>Aperture Diameter (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3569-1</td>
<td>4 1/2</td>
<td>4.3</td>
<td>3.6</td>
<td>2.3</td>
<td>1.9</td>
</tr>
<tr>
<td>3569-2</td>
<td>4 1/2</td>
<td>4.6</td>
<td>3.8</td>
<td>2.6</td>
<td>2.0</td>
</tr>
<tr>
<td>3569-3</td>
<td>4 1/2</td>
<td>4.3</td>
<td>3.4</td>
<td>2.2</td>
<td>1.8</td>
</tr>
<tr>
<td>No.  4</td>
<td>4 1/2</td>
<td>4</td>
<td>3.4</td>
<td>2.1</td>
<td>1.8</td>
</tr>
<tr>
<td>-------</td>
<td>--------</td>
<td>-----</td>
<td>-----</td>
<td>-----</td>
<td>-----</td>
</tr>
<tr>
<td>No.  5</td>
<td>4</td>
<td>3.2</td>
<td>2.4</td>
<td>1.7</td>
<td>1.4</td>
</tr>
<tr>
<td>No.  6</td>
<td>4</td>
<td>3.1</td>
<td>2.4</td>
<td>1.8</td>
<td>1.4</td>
</tr>
<tr>
<td>No.  7</td>
<td>3 1/2</td>
<td>3.6</td>
<td>3.0</td>
<td>2.0</td>
<td>1.7</td>
</tr>
<tr>
<td>No.  8</td>
<td>4</td>
<td>4.2</td>
<td>3.5</td>
<td></td>
<td>broken</td>
</tr>
<tr>
<td>No.  9</td>
<td>4</td>
<td>4.0</td>
<td>3.3</td>
<td>2.1</td>
<td>1.8</td>
</tr>
<tr>
<td>No. 10</td>
<td>4</td>
<td>4.0</td>
<td>3.0</td>
<td></td>
<td>broken</td>
</tr>
</tbody>
</table>

**Occurrence:**—A. 3510; B. 3508, 3509, 3636, 3622; C. 1771; D. 1759; E. 3461; F. 1777; H. present; J. 3506, 3410, 3422, 3427, 3441; K. 3479; L. 3343, 3354; N. 3371, 3363; N. 3401; O. 3359, 3364; Q. 3454, 3551; S. 3293, 3373, 3226, 3227, 3235, 3241, 3340, 3271, 3306, 3327; T. 3266; U. 3560; V. 3192; W. 3176; X. 3137; Y. 3167; Z. 3159; AB. 3191; AF. 3125; AM. 6176.

**Geologic Age:**—Late Wisconsinan.

**Remarks:**—The Wisconsinan mollusks of the Missouri Cotee district are not perceptibly different in shell form from Recent specimens I have seen. One exception to this statement is suggested by shells of the family Hydrobiidae. *Amnicola leightoni* Baker, 1920, was named for Pleistocene specimens from Ohio. The characteristics outlined by Baker (1920, p. 125, 1921, p. 29, and 1929, p. 119-120), for this species fit the specimens listed as *Amnicola linnaea* (Say), 1817, in this report. It is my opinion that Baker's species merely represents a portion of the species *A. linnaea* and is synonymous with the latter. The *A. linnaea* specimens I have seen from the Illinois Geological Survey Museum compare favorably with the specimens of *A. leightoni* from the same collections. Baker identified all of the material in the Illinois Geological Survey Museum collections and I believe that his assignment of specimens to *A. leightoni* is merely a fractionation of a group which is known to vary greatly in shell form. Dr. Elmer C. Berry of the Laboratory of
Parasitic Diseases. National Institute of Allergy and Infectious Disease, Bethesda, Maryland, has identified specimens from the New Farm site (5) as _A. ligna_ (personal communication).

**Phryn sp.**

Pl. 1 Figs. 12, 13.

**Description of fossil material:** Small to medium; 4 whorls stout-fusiform, sinistral, orthostrophic; moderately convolute with the body whorl shutting previous ones; last whorl comprises about 90 per cent of shell height; shell very thin, very fine thread transverse lines in former aperture positions; aperture large and ovate, with a distinct parietal callus; cryptophallus.

<table>
<thead>
<tr>
<th>Sample</th>
<th>No. of Whorls</th>
<th>Shell Height Diameter (mm)</th>
<th>Height of Last Whorl (mm)</th>
<th>Aperture Height Diameter (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3420-1</td>
<td>4</td>
<td>3.1</td>
<td>4.7</td>
<td>4.0</td>
</tr>
<tr>
<td>3420-3</td>
<td>3 1/4</td>
<td>3.5</td>
<td>3.2</td>
<td>3.0</td>
</tr>
<tr>
<td>1764-1</td>
<td>4</td>
<td>6.6</td>
<td>5.0</td>
<td>5.0</td>
</tr>
<tr>
<td>3444</td>
<td>2</td>
<td>1.5</td>
<td>1.4</td>
<td>1.2</td>
</tr>
</tbody>
</table>

**Occurrence:** C. 3597; Ø. 1764; G. 3560; J. 3420, 3430; N. 3390; E. 3444; F. 3326; AD. 3181.

**Geologic Age:** Late Wisconsinan.

**Remarks:** Most of the shells from the Missouri Coteau sediments appear to be immature specimens and lack sufficient characteristics for specific assignments. Identification of the species of this genus is beset with hazards because of the great morphologic variation of the tanae, presumably, in response to ecologic conditions. _Phryn_ is one of the genera of freshwater snails most able to endure generally adverse conditions. It is one of the most common of the genera of the Recent
small fauna of the Missouri Coteau. Its rarity, therefore, in Wisconsin molluscan communities is not easy to interpret. Ecologic pressure from other species of mollusks may be a logical explanation. Its rarity is not a statistical factor. The tendency for the shells to uncoil when dried and the large size of the body whorl may account for its scarcity in that it is extremely fragile and may be more poorly preserved.

_Lymnaea palustris_ (Muller), 1774.


(2) _Stagnicola palustris silden_ (Say). Baker, ibid., p. 212, pl. 13, figs. 3-7, 9-13.

(3) _Lymnaea palustris_ (Muller), Hubendick, 1951, Kungl. Svensk. Vetensk. Handl., ser. 4, v. 3, p. 64, 65, 119-122, figs. 190, 191, 195-203, fig. 303, b, m, and v (only).

_Description of fossil material:_—Large; 5 whorls, last whorl less than ½ total height, shoulders lacking, expansion of later whorls regular; eutreptomphalous; collumna fold weakly developed; not operculate; presences of fine transverse threads, some specimens malleted in last whorl.

<table>
<thead>
<tr>
<th>No. of Whorls</th>
<th>Shell Height (mm)</th>
<th>Shell Diameter (mm)</th>
<th>Aperture Height (mm)</th>
<th>Aperture Diameter (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>18.3</td>
<td>9.9</td>
<td>8.7</td>
<td>6.3</td>
</tr>
</tbody>
</table>

_Collected:_—5, 3580; v, 7201; AI, 6153.

_Sepiae Age:_—Late Wisconsinan.
Lymnaea stagnalis (Linnaeus) 1758

Pl. 1 Fig. 11

(1) Lymnaea stagnalis humeralis Say, Baker, 1923, Miss. Geol. Lab. Hist. Survey Bull. 70, pt. 1, p. 199-204, Pl. 11, fig. 6, 9, 10, 12 and 13 (only), Pl. 12, 4 (only).

(2) Lymnaea stagnalis (Linnaeus). Habendash, 1951, Kungl. Svenska Vetenskapshakademien Handlingar, Band 3, no. 1, p. 118-119, fig. 306 (E & F only).

Description of fossil material:- Large; 5-6 whorls, last whorl more than ¼ total height, adapical shoulder on last ¼ whorl, (shoulders rounded, spire attenuated, expanding rapidly in last whorl), cryptosphalous; columellar fold well developed; not operculate.

<table>
<thead>
<tr>
<th>Unit</th>
<th>No. of Whorls</th>
<th>Shell Height (mm)</th>
<th>Shell Diameter (mm)</th>
<th>Aperture Height (mm)</th>
<th>Aperture Diameter (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3209-1</td>
<td>6 1/2</td>
<td>44.1</td>
<td>22.6</td>
<td>23.5</td>
<td>14.3</td>
</tr>
<tr>
<td>3209-2</td>
<td>6</td>
<td>17.9</td>
<td>12.4</td>
<td>15.4</td>
<td>10.0</td>
</tr>
<tr>
<td>3209-3</td>
<td>6</td>
<td>30.6</td>
<td>15.9</td>
<td>17.7</td>
<td>9.9</td>
</tr>
</tbody>
</table>

Occurrence:- 5, 3240, 3209.

Geological Age:- Late Wisconsinan.

Remarks:- The fragility of the shells found at the Nee Farm site (8) precluded collection of many whole specimens. Many specimens were seen in the sediments during excavation of this site, only a few of which could be collected. Despite the small number of specimens in the collection, there seems little doubt that at one time during the existence of the aquatic environment at this site, Lymnaea stagnalis was a successful member of the molluscan community.

L. stagnalis shells were seen in the sediments of the Rodeck Farm site (V), but collection of whole specimens was impossible.
Lymania humilla Say, 1822

Pl. 1 Figs. 9, 10.


Description of fossil material: Medium, 4-54 whorls; attenuation, decalvate, orthostrophic, slightly involute, strongly shouldered, adapical profile of each whorl narrower in diameter than adapical profile, body whorl about 2/3 of height; narrowly to moderately umbilicate; transverse fine lines on all whorls except nuclear whorl and subsequent 1/4 whorl, whorls increase in diameter regularly, no callus; subrectangular, oblong-ovate aperture height always greater than 1/4 shell height in unbroken specimens, aperture with a slightly recurved peristomal lip partially constricting umbilicus; not eperculate.

<table>
<thead>
<tr>
<th>UMD #</th>
<th>No. of Whorls</th>
<th>Shell Height (mm)</th>
<th>Shell Diameter (mm)</th>
<th>Aperture Height (mm)</th>
<th>Aperture Diameter (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3511</td>
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<td>6.3</td>
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<td>3.6</td>
<td>1.8</td>
</tr>
<tr>
<td>3512</td>
<td>5</td>
<td>6.0</td>
<td>3.4</td>
<td>3.5</td>
<td>2.1</td>
</tr>
<tr>
<td>3513</td>
<td>4 1/2</td>
<td>5.6</td>
<td>3.2</td>
<td>2.9</td>
<td>1.8</td>
</tr>
<tr>
<td>3514</td>
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<td>6.2</td>
<td>3.2</td>
<td>3.2</td>
<td>3.0</td>
</tr>
<tr>
<td>3515</td>
<td>5</td>
<td>6.0</td>
<td>broken</td>
<td>3.3</td>
<td>broken</td>
</tr>
<tr>
<td>3516</td>
<td>4 1/2</td>
<td>5.0</td>
<td>2.9</td>
<td>2.9</td>
<td>1.9</td>
</tr>
<tr>
<td>3517</td>
<td>4</td>
<td>6.0</td>
<td>3.9</td>
<td>3.9</td>
<td>1.9</td>
</tr>
<tr>
<td>3518</td>
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<td>2.0</td>
<td>1.7</td>
<td>1.7</td>
<td>1.3</td>
</tr>
<tr>
<td>3567-1</td>
<td>5 1/4</td>
<td>7.4</td>
<td>3.0</td>
<td>4.1</td>
<td>2.4</td>
</tr>
</tbody>
</table>

(Continue...)— A. 3511; B. 3611; C. 3600; D. 1762; E. 3584; H. oocera; N. oocera; o. 3361; E. 3567, 3590, 3564; Y. 3177; Z. 3142; AA. 3145; AB. 3166; AC. 3153; Al. 6152.
Geologic Age:—Late Wisconsinan.

Remarks:—The species of the genus Lymnaea (in the sense of Hubendick, 1951, or the family Lymnaeidae in the sense of Baker, 1928a) are composed of groups which exhibit a wide variety of shell form. On the basis of neontologic as well as morphometric criteria, Hubendick (1951, p. 126–129) has grouped the following taxa into the species


*Gyransus parvus* (Say), 1817

Pl. 1 Figs. 4–6.


Description of fossil material:—Small; 3½–4 whorls, pseudo-planispiral, dextral, adovolute, shoulders rounded, abapical profile of
whorl slightly more obese than the adapical profile; surface ornamented with fine transverse costellae which occupy former aperture positions; nucleus sunken below subsequent whorls and unornamented; very wide apical and abapical umbilicuses, all whorls visible from either apical or abapical view; aperture deflected abapically except in shells with less than 3/4 whorls, forms a 45° angle with the axis of coiling, not operculate, without a callus.

<table>
<thead>
<tr>
<th>UND #</th>
<th>No. of Whorls</th>
<th>Shell Height Diameter (mm) (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3574-1</td>
<td>3 1/2</td>
<td>0.9    2.7</td>
</tr>
<tr>
<td>3574-2</td>
<td>3 1/2</td>
<td>0.9    2.9</td>
</tr>
<tr>
<td>3574-3</td>
<td>4</td>
<td>1.4    4.2</td>
</tr>
<tr>
<td>3574-4</td>
<td>3 1/2</td>
<td>0.9    2.9</td>
</tr>
<tr>
<td>3574-5</td>
<td>3 1/2</td>
<td>1.1    3.1</td>
</tr>
</tbody>
</table>

**Occurrences:** A. 3512; B. 3610, 3621, 3634; C. 1772, 3598; D. 1766; E. 3652; F. 1788; G. 3466, 3576; H. 3540; J. 3424; K. 3486; L. 3340; M. 3370, 3386; N. 3397; O. 3358; P. 3452, 3543; S. 3229, 3238, 3247; 3262, 3303, 3324, 3574; T. 3288; U. 3122; Y. 3174; Z. 3139; AA. 3147; AC. 3157; AJ. 3168; AF. 3150, 3117; AI. 6151; AJ. 6163; AM. 6170.

**Geologic Age:** Late Wisconsinan.

**Remarks:** The specimens assigned to this species were distinguished largely on the basis of their having a wide adapical and abapical umbilicus, slightly eccentric whorl profile, and the downward deflection of the last 3 whorls in larger specimens and the tendency toward this deflection in shells not yet fully developed. Specimens of a similar form and size, but lacking the above characters with the exception of the wide umbilicus, have been designated as *Cyrtulus* sp. It is quite possible that these latter specimens are merely a group of shell forms within the species *G. multus*. The matter is receiving further study.
Prosenus stenarchus (Say), 1821

Pl. 1 Fig. 7

(1) Planorbus (Monotax) stenarchus (Say). Bell, 1905, Harriman Alaska series, v. 13, p. 91.


(3) Prosenus stenarchus stenarchus (Say). Baker, 1945, Molluscan Family Planorbidae, p. 182.

Description of fossil material:-- Small; 4 whorls; pseudoplanispiral, dextral, orthostrophic, discoidal shoulder of last whorl terminates in an acute angle, involute, nucleus below next whorl and unornamented; aperture ovate, without a callus, frequently broken away; surface cancellate threads; moderately wide apical and abapical umbilicus exposes all whorls.

<table>
<thead>
<tr>
<th>UMO #</th>
<th>No. of Whorls</th>
<th>Shell Height (mm)</th>
<th>Shell Diameter (mm)</th>
<th>Abapical Umbilicus Diameter (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3249-1</td>
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<td>1.4</td>
<td>4.4</td>
<td>---</td>
</tr>
<tr>
<td>3259-2</td>
<td>4</td>
<td>2.0</td>
<td>6.7</td>
<td>---</td>
</tr>
<tr>
<td>1794-1</td>
<td>3 1/2</td>
<td>1.4</td>
<td>4.2</td>
<td>1.4</td>
</tr>
<tr>
<td>1794-2</td>
<td>3 1/2</td>
<td>1.4</td>
<td>4.3</td>
<td>1.2</td>
</tr>
<tr>
<td>1794-3</td>
<td>3 1/2</td>
<td>4.4</td>
<td>1.3</td>
<td>1.0</td>
</tr>
<tr>
<td>1794-4</td>
<td>3</td>
<td>1.0</td>
<td>2.6</td>
<td>0.9</td>
</tr>
<tr>
<td>1794-5</td>
<td>3 1/4</td>
<td>1.1</td>
<td>3.9</td>
<td>1.0</td>
</tr>
<tr>
<td>1794-6</td>
<td>3 1/4</td>
<td>1.0</td>
<td>3.6</td>
<td>0.8</td>
</tr>
<tr>
<td>3232-1</td>
<td>3</td>
<td>1.1</td>
<td>3.0</td>
<td>0.7</td>
</tr>
<tr>
<td>3232-2</td>
<td>3</td>
<td>1.0</td>
<td>2.8</td>
<td>0.8</td>
</tr>
</tbody>
</table>

References:-- B. 3616; D. 1794; F. 1782; G. 3565, 3467; J. 3413, 3423; K. 3482; L. 3372, 3360; M. 3399; N. 3456, 3549; O. 3446; S. 3232, 3249, 3261, 3325, 3575; T. 3286; Y. 3175; Z. 3143; AB. 3169, 3186; AC. 3152; AD. 3189; AF. 3118, 3126; AJ. 6166.

Geological Age:-- Late Wisconsinan.
**Arniiger criata** (Linne) 1758

**Pl. 1 Fig. 6**


**Description of fossil material:** Very small; 2-2½ whorls; pseudoplanispiral, dextral, apex flat, adapical profile angulate and interrupted by regularly spaced nodes which arise in thickened growth-interruption ridges; adapical profile rounded; surface ornamented with fine radial lines and ridges; the thickness of which varies in individuals; nucleus with spiral lines; sutures deeply impressed; umbilicus deep and wide; not operculate; without a callus.

<table>
<thead>
<tr>
<th>UNO #</th>
<th>No. of Whorls</th>
<th>Shell Height Diameter</th>
<th>No. of Nodes on Shell Periphery</th>
</tr>
</thead>
<tbody>
<tr>
<td>1760-1</td>
<td>2 1/2</td>
<td>0.4 (mm) 1.4 (mm)</td>
<td>18</td>
</tr>
<tr>
<td>1760-2</td>
<td>2 1/4</td>
<td>0.3 (mm) 1.0 (mm)</td>
<td>10</td>
</tr>
<tr>
<td>3598</td>
<td>2 1/4</td>
<td>0.4 (mm) 1.2 (mm)</td>
<td>16</td>
</tr>
</tbody>
</table>

**Occurrence:** B. 3590, 3615, 3629; D. 1760; F. 1765; G. 3586, 3464; J. 3406; K. 3008; S. 3518; AA. 3144; AD. 3190; AF. 3119, 3128; AI. 6150.

**Geologic Age:** Late Wisconsinan.

**Melisoma trivolvis** (Say) 1817.

(1) *Planorhina (Plataforma) trivolvis* (Say). Dall, 1905, Harriman Alaska Ser., v. 13, p. 80, fig. 68, 69.


Description of fossil material:— Large; 1½-2 whorls (immature specimens); pseudoplanispiral, sinistral, adapical carinae, adapical profile rounded; nucleus and first 1 to ½ whorls sunken below subsequent whorls; sutures deep; coarse radiating threads on all whorls save the nucleus; aperture roundedly lunate and recurved slightly, not expanded greatly, a distinct callos; umbilicus small, all whorls visible.

Occurrence:— C. 1795; F. 1779; U. 3402; Q. 3550.

Geologic Age:— Late Wisconsinan.

Remarks:— All specimens were fragmentary, therefore no measurements are available.

Helicosoma commanulatum (Say), 1821
Pl. 1 Fig. 1.

(1) Planorbis (Planorbella) commanulatum Say. Bull, 1905, Alaska Harriman Ser., v. 13, p. 90, fig. 70.


(3) Helicosoma commanulatum (Say). Baker, 1945, Moll. Fam. Planorbidae, pl. 106, fig. 1-12, 14-17 (only); pl. 109, 1-6.


Description of fossil material:— Medium; 5 whorls; planispiral, sinistral; whorl angulate at adapical shoulder through third whorl.
rounded thereafter, no carinae; surface with strong, regularly spaced transverse costae at former aperture positions; aperture strongly campanulate, last 1/8 of whorl expanded; parietal callus; narrow, deep umbilicus, nucleus and subsequent 2 whorls depressed.

<table>
<thead>
<tr>
<th>UND #</th>
<th>No. of Whorls</th>
<th>Shell Height Diameter (mm)</th>
<th>Aperture Height Diameter (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3002</td>
<td>4 1/2</td>
<td>4.2 8.3</td>
<td>5.0 4.6</td>
</tr>
<tr>
<td>3565</td>
<td>5</td>
<td>5.8 11.4</td>
<td></td>
</tr>
</tbody>
</table>

Occurrence: D. 1763; H. 3543; K. 3002; S. 3565; Y. 3171; AB. 3164; AC. 3154; AD. 3182.

Geologic Age: Late Wisconsinian.

Heliocosa ascens (Meeke), 1830

(1) Planorbid (Heliocosa) bicarinata Say. Bull, 1905, Harriman Alaska series, v. 13, p. 87, fig. 64.


Description of fossil material: Medium to large; 3 to 3½ whorls; planispiral, sinistral; whorl profile biaugulate, apical angulation forms an inward sloping ramp and in central whorls a carina, abapical angulation more acute than the apical one and forms an infundibulate umbilicus and a carina; nucleus small and visible from both above and below, unornamented; whorls with transverse costae at former aperture positions; umbilicus moderately wide, apical umbilicus shallow, all whorls visible in apical and abapical views; aperture campanulate, parietal callus.
<table>
<thead>
<tr>
<th>UND #</th>
<th>No. of Whorls</th>
<th>Shell Height Diameter (mm)</th>
<th>Aperture Height Diameter (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3256</td>
<td>3 1/2</td>
<td>7.0 12.7</td>
<td>6.0 7.2</td>
</tr>
<tr>
<td>3571-1</td>
<td>3 1/2</td>
<td>4.6 8.0</td>
<td>4.0 4.6</td>
</tr>
<tr>
<td>3571-2</td>
<td>3 1/2</td>
<td>4.3 7.7</td>
<td>3.8 4.4</td>
</tr>
<tr>
<td>3571-3</td>
<td>3</td>
<td>3.3 5.5</td>
<td>2.5 3.3</td>
</tr>
</tbody>
</table>

**Occurrence:**
- A. 3614; B. 3624; C. 1774; G. 3581; J. 3421; K. 3481;
- L. 3343; M. 3334; S. 3259, 3254, 3260; T. 3257; X. 3131; Y. 3172;
- W. 3140; A. 3155; A. 3150; AF. 3123; 3114.

**Geologic Age:** Late Wisconsinan.

**Remarks:** All of the specimens of *H. angas* found during this study appear to be smaller than specimens of the same species to be found on the Coteau and elsewhere in the central United States today.

**Ferrissia cf. F. tarda (Say), 1865**


**Description of the fossil material:** Very small, patelliform, apex eccentric to right and rear; concentric thread lines centering on apex (posterior margin broken).

<table>
<thead>
<tr>
<th>UND #</th>
<th>Height (mm)</th>
<th>Width (mm)</th>
<th>Length (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3256</td>
<td>0.5</td>
<td>1.0</td>
<td>1.4</td>
</tr>
</tbody>
</table>

**Occurrence:** 5. 3256.

**Geologic Age:** Late Wisconsinan.

**Remarks:** Only one specimen of the genus *Ferrissia* has been recovered from sediments of the Missouri Coteau. This may be due to the frail nature of this form and the unavoidable roughness of handling attendant to wet sieving.
Succinea avara (Say), 1824


Description of fossil material:—Medium; very thin, 3 whorls; width about 3/4 of height; aperture 2/3 of height, oval, no callus; surface ornamented with wrinkled lines in former aperture positions.

Occurrence:—C. 1796.

Geologic Age:—Late Pleistocene.

Remarks:—The assignment of members of the family Succindeidae to species on shell criteria alone is not possible with any degree of certainty. The shells seem to best satisfy the characters given for Succinea avara. The genus is extremely common in the Missouri Coteau district at present and the possibility that these specimens are included by contamination is raised by the striking paucity of terrestrial snail shells in the 40 sites reported here. Mr. Clayton, the collector of this site, has suggested the possibility that contamination of the sample may have occurred during collection. Succinea is, however, known to have occurred on the Great Plains throughout the Wisconsinan Stage and earlier (Leonard, 1950, p. 23, 24; 1952, p. 23, 24; Taylor, 1960, p. 78) so that its presence in Burnstad Drift is not anomalous.

Gastrocenta sp.

Description of fossil material:—Very small, relatively thick, 6 whorls, narrowly perforate; cylindrical; columellar imella fused
with parietal lamella forming an inverted Y in aperture, lower and outer apertural margin broken away.

**Occurrence:** B. 3594.

**Geologic Age:** Late Pleistocene.

**Remarks:** The genus *Gastrocopta* is represented in the Missouri Coteau district at present by at least 3 species. It is possible that the specimens of *Gastrocopta* from this site are included by contamination.
with parietal lamella forming an inverted 'Y' in aperture, lower and outer apertural margin broken away.

**Occurrence:** B. 3594.

**Geologic Age:** Late Pleistocene.

**Remarks:** The genus *Gastrocopta* is represented in the Missouri Coteau district at present by at least 3 species. It is possible that the specimens of *Gastrocopta* from this site are included by contamination.
BIBLIOGRAPHY


Fig. 1. *Helisoma campylogaster* (Say). Clear Lake site (K), approx. 3, 7 X, (UND 3002).

Figs. 2, 3. *Helisoma angustum* (Mean). Clear Lake site (K), approx. 5 X, 2. apical view, 3. abapical view.

Figs. 4-6. *Gyraulus parvus* (Say). Nue Farm site (S), 4. approx. 6.3 X, apical view, 5. approx. 7.4 X, abapical view, 6. approx. 7.4 X, apertural view, (UND 3574-3).

Fig. 7. *Pomponetina gracilis* (Say). Schlenker Farm site (D), approx. 6.8 X, (UND 1794-1).

Fig. 8. *Artemio cistata* (Linne). Nue Farm site (S), approx. 7.5 X, (UND 3318).

Figs. 9, 10. *Lymnaea humila* (Say). 9. Nue Farm site (S), approx. 4.6 X, (UND 3567-1), 10. Cleveland site (A), approx. 5.7 X, (UND 3511-7).

Fig. 11. *Lymnaea stagnalis* (Linne). Nue Farm site (S), approx. 1.4 X, (UND 3209-3).

Figs. 12, 13. Physa sp. 12. Mummy Cat Slough site (J), approx. 7.0 X, (UND 3420-3), 13. Schlenker Farm site (D), approx. 5.7 X, (UND 1764-1).


Fig. 15. *Valvata lewisi* Currier. Rosenthal 2 site (M), approx. 4.9 X, (UND 3385-2).

Fig. 17. *Amnicola* sp. Nue Farm site (S), approx. 8 X, (UND 3493).

Figs. 18, 19. *Amnicola limosa* (Say). Nue Farm site (S), 18. approx. 5 X, (UND 3569-1), 19. approx. 4.2 X, (UND 3569-4).

Fig. 20. *Ferrissia* sp. Nue Farm site (S), approx. 6 X, (UND 3256).

Fig. 21. *Pisidium* sp. Nue Farm site (S), approx. 2.3 X, (UND 3220-5).
Fig. 1. *Amodonta grandis* Say. Nue Farm site (S), approx. 1.3 X, (UND 3207-1).

Figs. 2, 4. *Sphaerium* sp. 2. Nue Farm site (S), approx. 3.6 X, (UND 3301); 4. Cleveland site (A), approx. 4.2 X, (UND 3521-1).

Fig. 3. Pearl from naiaad. Lowenthal site (I), IX, (UND 3336).

Figs. 5-7. *Lamellilis radiata siliqueoides* (Barnes). Nue Farm site (S), 5. female, right valve, showing produced posterior and posterior-ventral margins typical of this sex in this species, approx. 1.2 X, (UND 3241); 6. articulated valves of male showing excellent preservation of shell and ligament fibers, approx. 0.7 X, (UND 3279); 7. male, left valve, approx. 0.8 X, (UND 3213-1).