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by

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A MOLLUSCAN FAUNA AND LATE PLEISTOCENE CLIMATE IN SOUTHEASTERN NORTH DAKOTA

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INTRODUCTION

In August, 1959, Dr. Mark Rich, while conducting investigations for the North Dakota Geological Survey in Stutsman County, North Dakota, discovered an abundant freshwater molluscan fauna in a sand and gravel pit approximately two miles southwest of the village of Cleveland. The site (hereafter referred to as the Cleveland site) is in the SW¼, Sec. 17, T. 139 N., R. 67 W., Cleveland SW quadrangle. The surrounding topography and stratigraphic relationships unquestionably established the sediments of the pit as late Wisconsinan in age and as being ice-contact deposits, *i. e.*, as having been deposited in a body of water which depended upon blockage by glacial ice for its existence. Realizing the implications of such a fauna, Dr. Rich collected some of the larger mollusks and later brought his discovery to the attention of Drs. Wilson M. Laird, North Dakota State Geologist and Professor of Geology and F. D. Holland, Jr., Associate Professor of Geology at the University of North Dakota. In subsequent conferences, it was decided that further studies of this fauna should be made to determine the possible value of studies of Pleistocene molluscan faunas in connection with glacial geology of the state.

In the summer of 1960, while mapping glacial geology in Logan, McIntosh, and Kidder Counties, North Dakota, Messrs. Lee Clayton and John W. Bonneville, graduate students in the Department of Geology at the University of North Dakota, discovered six other exposures of fossiliferous ice-contact deposits. Independently, Mr. Charles Huxell of the United States Geological Survey discovered yet another exposure of fossiliferous ice-contact deposits in Stutsman County. To the writer's knowledge these comprise the entire number of ice-contact deposits known to contain Pleistocene freshwater mollusks in North America (Clayton, 1961, Fig. 1). Baker (1, 2, 3, 4), Shimek (17), Leonard (13), 14, 15), Leonard and Frye (16), Dall (7), Taylor (18, 19) and Winkler (20) have described many Pleistocene faunas, but these have all been from proglacial deposits or from areas remote from the ice sheet.

On October 14, 1960, the writer with the assistance of Mr. Kent A. Madenwald, both graduate students in the Department of Geology at the University of North Dakota, visited the Cleveland site and systematically sampled both the fauna and the sediments. These samples were later studied by the writer in the laboratory at the

University of North Dakota, and provided the basis for the conclusions here presented.

METHODS

A series of fifteen samples was taken from the north face of the sand and gravel pit at the Cleveland site and placed in properly labeled, individual plastic bags. Samples were taken at eight-inch vertical intervals and each contained approximately two kilograms of sediments. Fossils of sufficient size to be recognized in the outcrop were collected and their orientation *in situ* noted. The various layers of sand and gravel were both photographed and sketched and the dip of the beds measured with a Brunton compass.

Each sample was examined under the binocular microscope (at magnifications of 54X and 108X,) the organic material removed and stored for later examination, and the sediments analyzed mechanically be sieving. The median grain size of each sample was plotted logarithmically against that percentage of the total number of specimens which it contained (see Fig. 1).

The fossils were identified, using the works listed above and those of Jones (12) and Berry (5). The preferred habitats, as given in the literature, of the still extant species was tabulated for comparison (see Fig. 2). The present range of two mollusks which have restricted present ranges were plotted on an outline map of North America (see Fig. 3).

RESULTS

The following is a systematic list of the fossils taken from the Cleveland site:

Phylum MOLLUSCA
- Class GASTROPODA
  - Subclass PROSOBRANCHIA
    - Order MESOGASTROPODA
      - Family VALATIDAE
        - *Valvata tricarinata* (Say)
        - *V. bicarinata* Lea
        - *Amnicola leightoni* Baker
      - Family LIMNAEIDAE
        - *Fossaria obrussa* (Say)
      - Family PLANORBIDAE
        - *Gyraulus parvus* (Say)
        - *Gyraulus* sp.
        - *Helisoma anceps* (Menke)
        - *Helisoma* sp.
- Class PELECYPODA
  - Order PRIONODESMACEA
    - Family UNIONIDAE
      - *Andonta grandis* Say
      - *Anodontoides ferussicainus* (Lea)

Order TELEODESMACEA
Family SPHAERIDAE
Sphaerium simile (Say)
Pisidium sp. A
Pisidium sp. B
Pisidium sp. C
Phylum ARTHROPODA
Subphylum CRUSTACEA
Class OSTRACODA
Family CYPRIDAE
Eucypris sp. A
Eucypris sp. B
Phylum CHORADATA
Subphylum VERTEBRATA
Class AVES?*

*Several calcareous particles having a regular curvature and thickness were found at two horizons in the outcrop. After comparison under the microscope with chicken egg shells, these fragments were tentatively assigned to this class.

Kingdom PROTISTA
Phylum CHLOROPHYCEAE
Class CHAREAE
Family CHARACEAE
Chara sp.

The mechanical analysis yielded the following data:

Level below the surface in inches	Median grain size in millimeters	Size Grade
15	½ - 1	Coarse sand
21	8 - 16	Medium pebbles
29	8 - 16	Medium pebbles
37	2 - 4	Very fine pebbles
45	2 - 4	Very fine pebbles
53	1 - 2	Very coarse sand
61	.25 - .125	Fine sand
69	.125 - .0625	Very fine sand
77	.125 - .0625	Very fine sand
85	.125 - .0625	Very fine sand
93	.25 - .125	Very coarse sand
101	2 - 4	Very fine pebbles
109	1 - 2	Very coarse sand
117	1 - 2	Very coarse sand
125	.25 - .125	Fine sand

These data indicate that the flow of water depositing the sand layers experienced two interruptions, when faster water deposited the two gravel beds. The grain size of most of the samples containing mollusks was in the fine sand (½ to ¼ mm) range and is indicative of relatively slowly moving water. *Anodonta* and *Anodon-*

toides shells were found in the fine sand and very fine sand in positions indicative of a biocoenose. At both of the contacts of fine sand with overlying gravel, specimens were found to be rotated, crushed and filled with larger sediment. This was taken as evidence that these pelecypods lived in the fine sand environment and were killed by rapid burial by gravel, and that the aquatic environment thus underwent two cycles of deposition unfavorable to the pelecypods.

DISCUSSION

The fauna unquestionably lived in close proximity to the glacier which occupied southwestern North Dakota during the late Wisconsinan Age of Frye and Wilman (10). Thus any climatic conditions inferred from the fauna will better illustrate the conditions at the glacial front than faunas from more distant locations. This is of special significance in that this fauna and those described by Clayton (6) are apparently the first from ice-contact deposits.

Being aquatic, this fauna and those of Clayton (6) form a better basis for inferring climatic conditions than do those containing primarily terrestral organisms which are subject to both humidity and temperature factors in the climate. No unquestionable technique for separating the effect of these two factors has yet been suggested. Thus most of the work based upon botanical and non-aquatic biological evidence remains in question, Shimek (17), and Eiseley (8).

The lithologic, topographic, and biologic information derived from this study are in complete accord. The grain size of most of the sediments indicates a slowly moving body of water, and the dip of the beds suggests that this might have been at the inlet of a stream in a small lake. The high elevation of these lake sediments above the surrounding terrain and the presence of nearby "stagnation moraine" features proves the intimacy of these deposits with the glacier. The fauna is a comingled northern and middle latitude assemblage. The Pleistocene range of *Valvata tricarinata* and *V. bicarinata* experienced a marked southern shift into Oklahoma and Texas during the Yarmouthian Age according to Taylor (19) and Taylor and Hibbard (18). No corresponding shift of the middle latitude clam, *Anodonta*, has been reported. *Anodonta* is found in the lowest beds sampled at the Cleveland site, thus it was not forced to retreat any great distance from the glacial front by adverse climatic conditions.

This picture of freshwater mollusks living in lakes on the Pleistocene ice sheet may at first appear anomalous. Glaciers today are found primarily in the higher latitudes and have become so associated in thought with Arctic climate that we assume the climatic conditions during Pleistocene glaciation must have been rigorous. However, it is unlikely that the climate was very warm. The mechanical analysis and environmental preferences of the extant species supports this idea. It is highly unlikely that the amount of detritus which would be carried in water from rapidly melting glacial ice would

permit successful occupation by mollusks. Thus it may be assumed that the aquatic environment was much like that which is mutually included in the present ranges (see Fig. 3) of *Valvata* and *Anodonta,* i.e. the Great Lakes, the upper Mississippi River, and the upper Ohio River drainages.

SUMMARY

It is concluded that the climate during the late Wisconsinan Age during which this fauna lived was not rigorously cold, nor excessively warm, and probably approximated that which now exists in the Great Lakes region of the United States. The glacial ice melted slowly and was insulated by drift. The bodies of water on the ice were warmed sufficiently by the sun to permit the development of extensive molluscan faunas. Waters in front of the glacier were not greatly depressed in temperature, as indicated by the presence of still extant species of pelecypods, which do not have a range more northern than the Winnipeg Lakes, in the lowest layers of sediments sampled.

Further studies of Pleistocene mollusks are strongly urged as an aid to our better understanding of the glacial history of North Dakota.

ACKNOWLEDGMENTS

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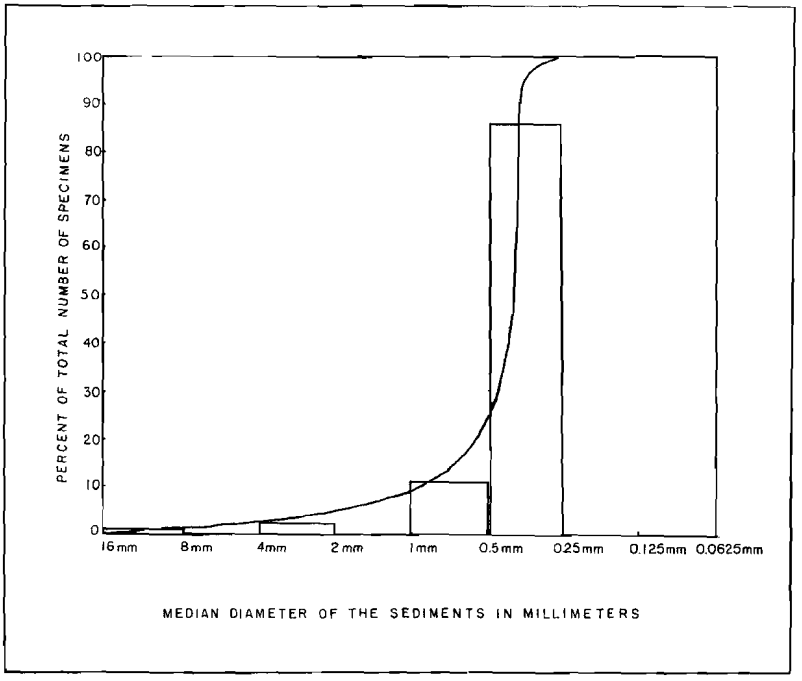

FIGURE 1. Histogram and cumulative curve showing the relationship between the median grain size of the sediment samples and their fossil content. Those samples having a median grain size in the medium sand range (½ to ¼ mm) contain approximately 85% of the organic material.

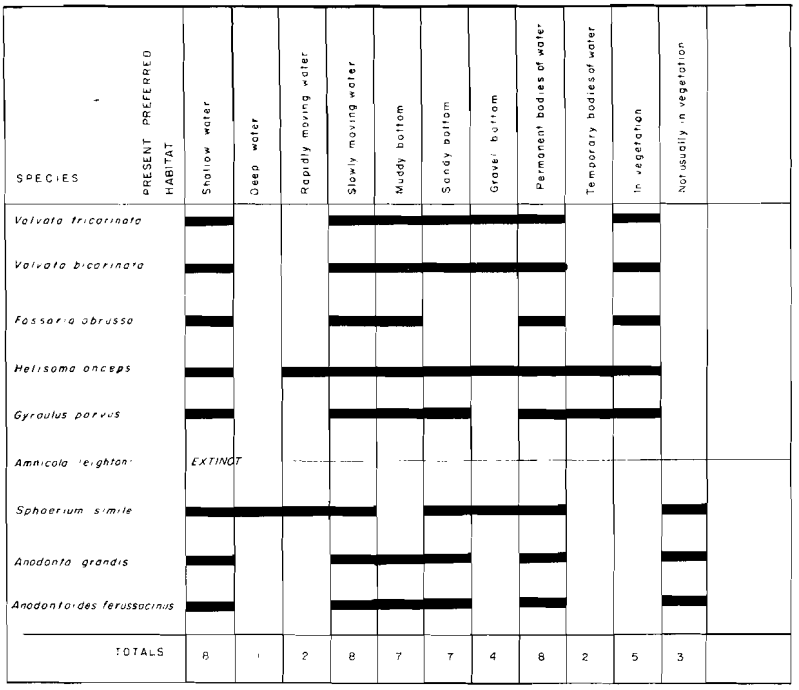

FIGURE 2. Chart representing the preferred habitats of selected extant species from the fauna at the Cleveland site. The fauna probably lived in a shallow, permanent, slowly moving body of water on a muddy or sandy bottom which had some vegetation.

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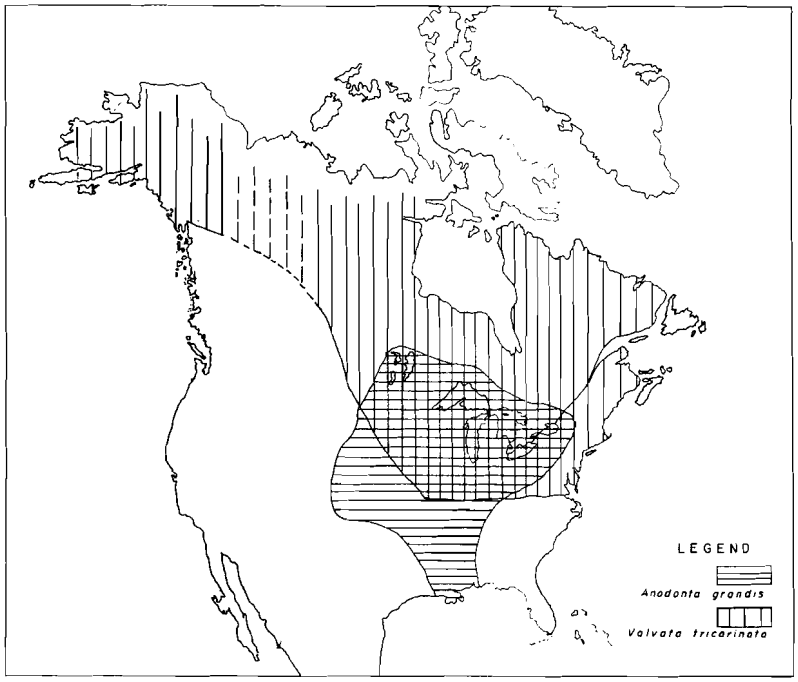

FIGURE 3. Sketch map of North America showing the modern ranges of *Anodonta grandis* and *Valvata tricarinata.* The overlapping portions of their ranges provide a reasonable basis for reconstructing the environment in which the fossil fauna from Cleveland, North Dakota, lived.