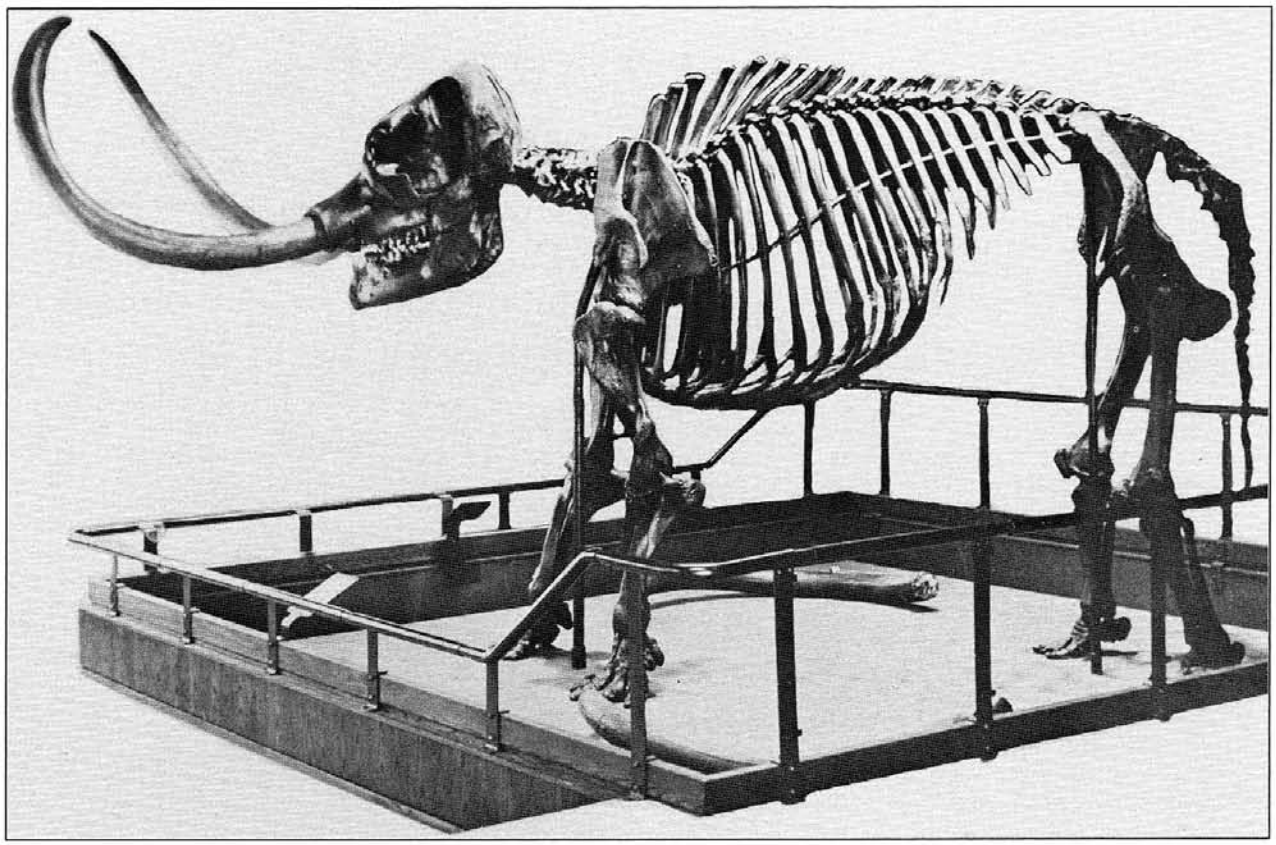
WINTER 1992

Ohio Geology

a quarterly publication of the Division of Geological Survey

BESTIARY OF PLEISTOCENE VERTEBRATES OF OHIO

by Michael C. Hansen



Skeleton of the Conway mastodon, Mammut americanum, *found in Clark County in 1878. This specimen, a large male, is now displayed at the Ohio Historical Center in Columbus. Photo courtesy of the Ohio Historical Society.*

A large and diverse fauna of vertebrates inhabited Ohio during the Pleistocene Ice Age. Remains of these animals are comparatively common in some areas of the state, particularly in bog or lake deposits and in sand and gravel outwash. The first cave fauna reported from Ohio was discovered in Indian Trail Caverns in Wyandot County. Many new records have been added to Ohio's Pleistocene bestiary from this site, which will be described in the Spring 1992 issue of *Ohio Geology*. Another noteworthy Ohio site is the Carter site in Darke County. This former glacial lake was systematically excavated by the Dayton Museum of Natural History in the early 1970's and produced abundant remains of Pleistocene vertebrates. It is probable that similar systematic excavations at other bog sites would produce a similar diversity of Pleistocene vertebrates.

These vertebrate remains are represented by bones and teeth, which are commonly found disarticulated, that is, the individual bones of the skeleton are no longer in a life position of articulation with the remainder of the skeleton. Although these Pleistocene bones are certainly regarded as fossils, they are generally in their original state with little, if any, permineralization. Owing to this fact, it is probable that bones of many smaller vertebrates are mistaken for those of recently deceased animals and given little regard by uninformed or inexperienced collectors. On the other hand, bones of large mammals such as mastodon or mammoth are seldom overlooked because of their enormous dimensions. This circumstance probably accounts for the overwhelming dominance of mastodons and mammoths in Ohio's Pleistocene record.

Oliver P. Hay included Ohio Pleistocene vertebrates in his 1923 compilation of occurrences of these animals east of the Mississippi River. In 1963, former Survey geologist Dr. Jane L. Forsyth, now at Bowling Green State University, published a list of Pleistocene vertebrates known from Ohio. This list has served as the primary compilation of Ohio's Pleistocene

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George V. Voinovich, Governor • Frances S. Buchholzer, Director

FROM THE STATE GEOLOGIST . . . by Thomas M. Berg

ICE AGE EVENTS IMPACT ALL CITIZENS!

The title of this editorial might make a good headline for a science fiction story or a weekly tabloid article. It evokes images of prehistoric humans battling for survival with mastodons and sabertooth cats, and fur-clad hunters migrating across icy terrains swept by bone-chilling blasts of arctic wind. In fact, the effects of the Ice Age, or the Pleistocene Epoch as geologists call it, really do impact the lives of all Ohioans. Hardly a day goes by at the Division of Geological Survey when we do not make important decisions and determinations that involve the results of erosion and deposition which took place during the Pleistocene. We are also concerned about events of the post-Pleistocene, or Holocene Epoch. (The Pleistocene and Holocene together are called the Quaternary Period.) We are likewise becoming increasingly concerned with what happened to Ohio's landscape *before* the glaciers came crunching into our state. At least 240 million years elapsed between the deposition of the Permian-age Greene Formation in southeastern Ohio and the deposition of the earliest Pleistocene glacial deposits exposed in southwestern Ohio.

About three-fourths of Ohio is covered by variable thicknesses of glacial deposits. The 1961 *Glacial map of Ohio* shows a very interesting pattern of unconsolidated sediments left by mile-thick continental ice sheets which advanced from neighboring Canada and then melted. These sediments, variously mapped as till sheets, moraines, lake deposits, loess, and stratified glaciofluvial materials, have a profound impact on the vast majority of Ohio's citizens. There are pluses and minuses. Glaciofluvial deposits on land and deposits within the bed of Lake Erie include vast resources of sand and gravel used in construction of highways, homes, schools, hospitals, shopping centers, and factories. In 1990, 44,057,557 tons of Ohio sand and gravel were sold at a value of $154,163,522! Almost all of our rich agricultural soils are developed on glacial deposits. Thick glacial deposits (some exceeding 700 feet) filling buried valleys in Ohio are some of the most valuable and productive aquifers in the nation.

There are also liabilities that come with glacial deposits. In Hamilton County, where landslide damage costs more per capita than in any other county in the United States, glacial lake clays and silts play a significant role. Glacial lake deposits along the Cuyahoga Valley in northeastern Ohio frequently fail, bringing down tons of material. Bluffs of till and glacial lake sediment along the Lake Erie shoreline continually collapse as erosion undercuts them, costing millions of dollars annually in property loss. Landslides in bedrock material are exacerbated by the fact that the rock was subjected to severe freeze-thaw conditions during the Ice Age. Colluvium covers many slopes in the nonglaciated southeastern part of Ohio and is largely due to breakup of bedrock materials during intensely cold (periglacial) climatic conditions when glaciers covered the remainder of the state. Landslides in colluvium are a common geologic hazard. Catastrophic downhill movement of huge blocks of sandstone is also due in part to the expansion of fractures during periglacial conditions.

In addition to landslide hazards, there are other concerns involving glacial and periglacial deposits. Safe disposal of municipal, hazardous, and low-level radioactive wastes requires that such deposits be carefully mapped and characterized. Detailed geologic mapping of Ohio's glacial and periglacial deposits is an enormous undertaking that should keep pace with the issue of waste disposal. Recent severe drought conditions and burgeoning demands for water also require accelerated mapping of buried valleys and identification of glacial aquifers. New funding for building and improving Ohio's highways will require detailed geologic maps showing the distribution and properties of surficial deposits. There is a correlation between the hazard of indoor radon and some glacial deposits; such materials need to be mapped. There is increased concern about earthquakes in Ohio. Many deposits of glacial lake sediments in our state could liquefy during a major seismic event, causing the collapse of large structures. Recent mapping and dating of disturbed sediments in Missouri, Indiana, and other nearby states have revealed the signature and timing of important prehistoric seismic events. Such research on Ohio's surficial deposits needs to be carried out in order to better predict earthquakes.

As I mentioned above, the Division of Geological Survey is increasingly interested in what happened during the long span of geologic time between deposition of the youngest beds of Ohio's Paleozoic bedrock succession and deposition of the first Pleistocene glacial sediments. We have no clear record of what transpired during the Mesozoic Era in Ohio. The dinosaurs of that era probably would have witnessed nothing other than continual erosion of the land. We also have no clear record of events of the Cenozoic Era prior to the Pleistocene in Ohio. The prehistoric mammals of that time probably witnessed a lot of erosion too. As we travel around nonglaciated southeastern Ohio though, we are beginning to see indications of profound weathering harkening back to earlier Cenozoic time when the climate was much different than now or during the Ice Age. We are discovering that saprolite (literally "rotten rock") is more extensive than previously recognized. Particularly in exposures of porous sandstone such as the Black Hand, thick, bright-orange saprolite retains original layering of the rock but can be excavated and broken with bare hands. It is important that geologists attempt to map and characterize the occurrence of saprolite, because the engineering characteristics are vastly different than those of unweathered rock.

A diminishing budget has reduced the Survey's surficial mapping capability to one and one-half positions. In 1987, seven positions were dedicated to surficial mapping. Given the importance of glacial, periglacial, and preglacial deposits in our daily lives, the Division and all Ohioans face a precarious situation. The continually growing demand for environmental geology assessments clearly justifies rebuilding of the Quaternary Geology and Mapping Subsection in the our Regional Geology Section. One of my highest priorities is to find adequate funds to rebuild this subsection—a big challenge during this time of severe economic recession!

Our readers, especially those in policy-making positions, should know that we are doing everything possible to provide the maps and information on surficial deposits that are so urgently needed. Our statewide bedrock mapping project in cooperation with the USGS COGEOMAP program is generating bedrock-topography maps—a necessary tool for determining the thickness of glacial and other surficial deposits. The state glacial map published in 1961 is out of date and contains significant errors. To address current needs, the Division is preparing an interim statewide surficial geology map by Ohio State University Emeritus Professor Richard A. Goldthwait, and Survey geologists Rick Pavey, Dennis Hull, Scott Brockman, and Robert Van Horn. This project is being carried out in cooperation with Dr. Garry McKenzie of the OSU Department of Geological Sciences and the USGS Water Resources Division, Ohio District Office. The map is being compiled at a scale of 1:250,000, and the compilation sheets are scheduled to be placed on open file by October 1992. A full-color state map at a scale of 1:500,000 will be published before the end of this biennium, pending available funds. When our Quaternary Geology and Mapping Subsection is rebuilt, the urgently needed detailed surficial-materials mapping will continue on a quadrangle scale. Ice Age events do indeed impact all citizens! But we cannot cope with the situation without knowing the characteristics and distribution of the deposits!

OHIO GEOLOGY

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vertebrates. Since 1963 new occurrences have been recorded in the literature or have been compiled informally at several institutions, including the Division of Geological Survey. The following list is based on all of these sources; however, there are probably many omissions.

Although Hay, in his 1923 work, alluded to the possibility that some occurrences of Pleistocene vertebrates might be in sediments deposited in the interval (known as the Sangamon) between the Illinoian and Wisconsinan glaciations, radiocarbon dates from more recently discovered sites cast doubt on that hypothesis. These dates all appear to fall between about 18,000 years ago and 10,000 years ago, the time when the Wisconsinan glacier began its withdrawal from Ohio and the end of the Ice Age. According to Dr. H. Gregory McDonald of the Cincinnati Museum of Natural History, only the occurrence of a specimen of *Bison latifrons* in Brown County in 1869 might possibly be Sangamonian in age. This suggestion is based on the observation that this long-horned, extinct bison was common in the Illinoian and Sangamonian; however, *B. latifrons* survived into the late Wisconsinan in the western U.S. and may have even survived into early postglacial time in the east.

Most records of small vertebrates have come from just two Ohio sites—Indian Trail Caverns and the Carter site. The majority of records of large mammals such as mastodons and mammoths consists of the discovery of a single skeletal element, most commonly a tooth. However, a number of sites have produced nearly complete skeletons of these large proboscideans (see *Ohio Geology,* Winter 1990). Many of the older records of these animals must be viewed with some reservation, as the skeletal elements have not survived for confirmation of identification. They may have been misidentified in the original account of the discovery, which may have been in a nonscientific publication written by an individual unskilled in such identifications. Although teeth of mastodons and mammoths are easily recognized, other skeletal elements of these animals require expert opinion for identification. Tusks of these proboscideans are difficult to assign to one species or the other, particularly when they are found as incomplete or fragmentary specimens.

In addition, presumed Pleistocene occurrences of extant species may sometimes be in error. Reported occurrences of horse, deer, elk, modern beaver, bison, and many small mammals may actually be Recent animals rather than Pleistocene ones. This is particularly true for older discoveries in which the stratigraphic context was poorly defined and radiocarbon dating was not available.

We tend to think of the Pleistocene Ice Age as an event of long ago that was characterized by bizarre, long-extinct animals. It may be surprising to many people to learn that of the 38 species of mammals known from Ohio's Pleistocene deposits, 27 species—more than two-thirds—still survive. Nineteen of these species still live in Ohio, including black bears, which have recently migrated into the state. Eight species—porcupine, grizzly bear, pine marten, fisher, bison, elk, caribou, and tundra muskox—still survive elsewhere in North America. Caribou and muskox, creatures of the tundra, probably left Ohio at the end of the Pleistocene. The other species, except grizzly bear, survived in Ohio until historic times. Horse and tapir are categorized as extinct animals because they both became extinct in North America at the end of the Pleistocene and it is probable that surviving species of these animals are not the same species that lived here during the Pleistocene.

The extinction of a portion of the Pleistocene fauna remains one of the great mysteries in the history of life on Earth. This extinction was so recent that we have a comparatively good record of the animals and their environments and we can accurately date this event by radiocarbon and other techniques. Indeed, the preserved record is so good that we perhaps overemphasize the importance of this extinction. Had this extinction occurred tens or hundreds of million years ago, with a correspondingly poor fossil record of the event, we might regard it more as a perturbation in life history than as a catastrophic event.

Cataclysmic occurrences such as meteorite impacts or massive volcanic eruptions cannot be invoked to solve this puzzle, so we must look to other causes. Most of the animals that disappeared at the end of the Pleistocene, about 10,000 years ago, were large herbivores, or carnivores that preyed on these herbivores. This fact, among others, led Paul S. Martin of the University of Arizona to propose that this apparently selective extinction was caused or hastened by the invasion of North America by Paleo-Indians crossing the Bering Strait and spreading southward across North and South America. According to Martin's theory, these skilled hunters reduced the populations of comparatively slow-breeding large herbivores to the extent that these animals soon became extinct.

Other workers have suggested that climatic change, with a subsequent vegetation change, was the primary cause of this extinction. These climatic theories propose that massive changes in vegetational distributions, and particularly vegetational diversity, caused many narrowly adapted herbivores, and their predators, to become extinct. Such events are complex and it is probable that no single cause is totally responsible for the extinction. Climatic change, vegetational change, and so-called overkill by Paleo-Indians may have all been contributing factors. Certainly, it teaches us caution in interpreting more ancient events, such as the extinction of dinosaurs at the end of the Mesozoic, in simplistic fashion.

PLEISTOCENE VERTEBRATE REMAINS FROM OHIO

** denotes extinct species*

Osteichthyes (bony fish)

Remains of Pleistocene fishes have been reported from only two sites in Ohio: the Carter site (Darke County), where bones of several small species, including a mudminnow, *Umbra limi,* were discovered, and Indian Trail Caverns (Wyandot County), where bones of as-yet unidentified minnows have been found.

Amphibia

At least two species of frogs have been found at Indian Trail Caverns.

Reptilia

Remains of two species of turtles, *Chelydra serpentina* (snapping turtle) and *Chrysemys picta* (painted turtle), were reported from the Carter site. Snapping turtle remains were reported to be in association with the Johnstown mastodon in Licking County and in a marsh in Erie County. Two species of turtle and two species of snake have been found at Indian Trail Caverns.

Aves (birds)

The Carter site has produced unspecified remains of birds, as has the Indian Trail Caverns site. In addition to small birds, the Indian Trail Caverns site has produced the remains of an owl and a turkey (*Meleagris gallopavo*). The claw of a hawk was found at the Orleton Farms mastodon site in Madison County. Forsyth (1963) reported the remains of a Canada goose from Castalia marsh in Erie County and the remains of a duck

from Hamilton County. It is undetermined if the latter two occurrences are Pleistocene or Recent. An undescribed sparrow-size bird has been found at Quillin bog in Medina County.

Mammalia

Insectivora

Remains of shrews, *Sorex* sp., *Cryptotis* sp., and *Blarina* sp., are known only from Indian Trail Caverns.

Chiroptera

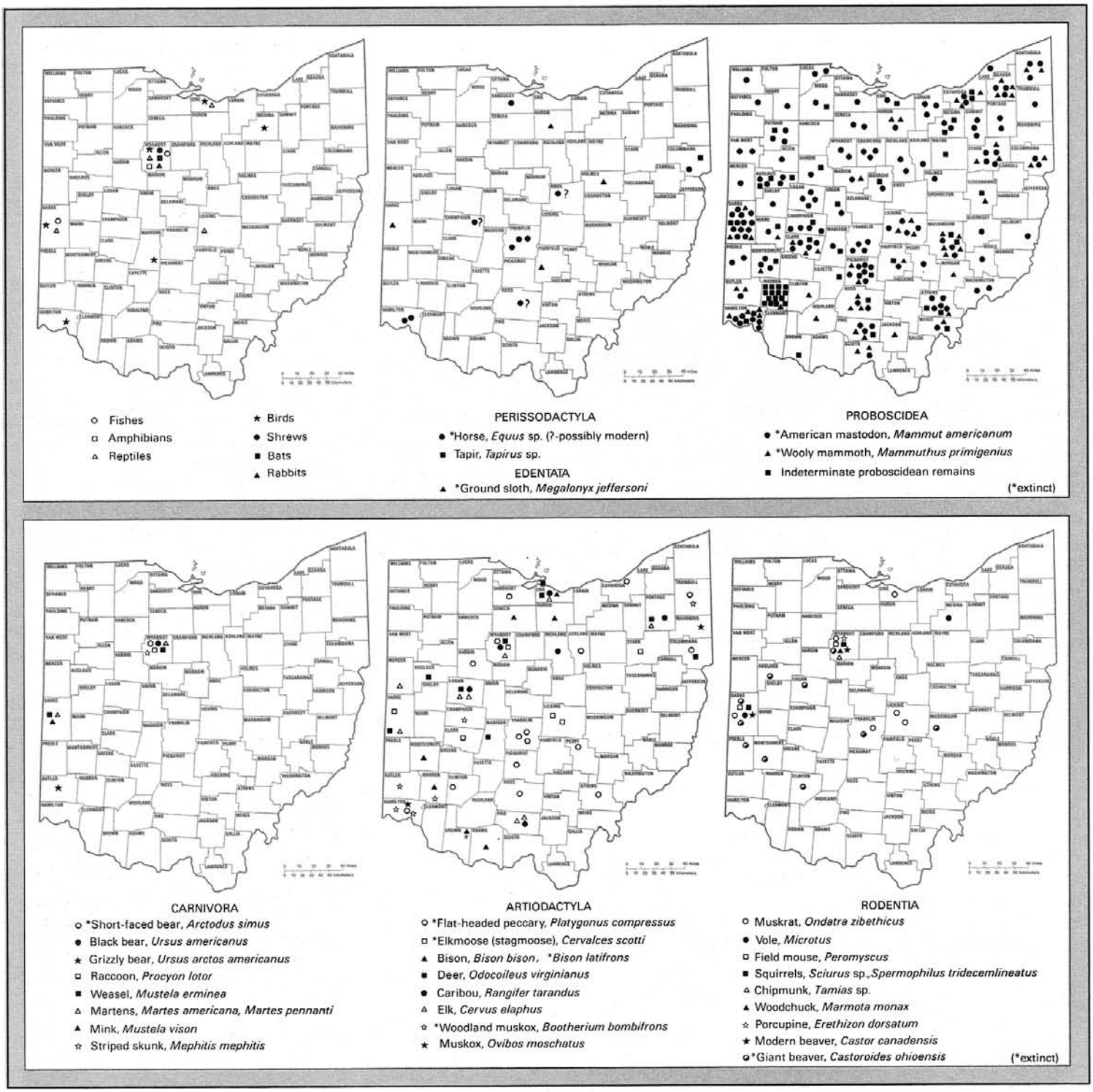
Remains of a Pleistocene bat, *Myotis,* have been reported only from Indian Trail Caverns.

Lagomorpha

Rabbit remains have been reported only from Indian Trail Caverns.

Rodentia

Most rodents are small herbivores and are extremely abundant. Owing to their small size, few have been reported from Ohio's Pleistocene sediments. Larger rodents, particularly giant beaver, have been recognized more frequently. At least 11, and possibly 12, individuals of this black-bear-size rodent are known from Ohio, including the type specimen of *Castoroides ohioensis,* described and figured by J. W. Foster in the 1838



Distribution of Pleistocene vertebrate remains in Ohio.

First Annual Report of the Ohio Geological Survey. This specimen was discovered near Nashport in Muskingum County. It is thought that giant beavers did not build dams nor gnaw trees but lived on aquatic vegetation. The Rodentia identified from Ohio are listed below.

Microtus (meadow vole), Carter site, Indian Trail Caverns, Quillin bog.
Peromyscus (field mouse), Carter site, Indian Trail Caverns.
Ondatra zibethica (muskrat), Carter site, Indian Trail Caverns, Northern Lights site (Franklin County), Johnstown mastodon site (Licking County), Burning Tree mastodon site (Licking County).
Sciurus sp. (tree squirrel), Indian Trail Caverns.
Spermophilus tridecemlineatus (ground squirrel), Carter site.
Tamias sp. (chipmunk), Indian Trail Caverns.
Marmota monax (woodchuck), Indian Trail Caverns.
Erethizon dorsatum (porcupine), Indian Trail Caverns.
Castor canadensis (modern beaver), Carter site, Indian Trail Caverns.
**Castoroides ohioensis* (giant beaver), see map.

Edentata

**Megalonyx jeffersoni* (ground sloth), a large browser of the forest that was about the size of an ox, has been identified from the Carter site, Fairfield County, Holmes County, and Huron County. The specimen from the Carter site and the Holmes County specimen, collected in 1890, are nearly complete. The former specimen is at the Dayton Museum of Natural History and the latter specimen is displayed at Orton Geological Museum at The Ohio State University.

Perissodactyla

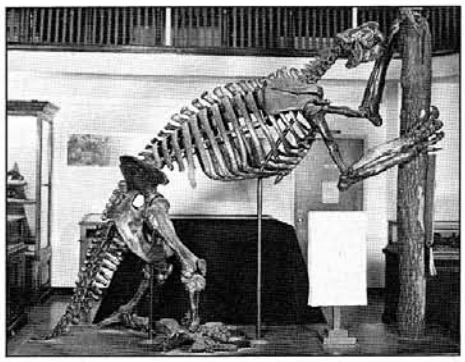
Horses became extinct in North America at the end of the Pleistocene, but were reintroduced at the time of European exploration and settlement. Ten occurrences of **Equus* sp. (horse) have been reported from seven Ohio counties (see map). Horse remains reported from Ohio consist primarily of isolated teeth and jaws and have not been studied in detail. There is a distinct possibility that some reported occurrences of horse remains represent modern horses interred in Pleistocene sediments in historic time.

A jaw of a tapir (*Tapirus* sp.) was reported from Columbiana County, probably about 1850. Several contemporary paleontologists referred to the specimen, which is apparently now lost. It is distinctly possible that this was a correct identification.

Artiodactyla

Artiodactyls are even-toed herbivores of medium to large size. Bison, elk, and white-tailed deer survived into historic times in Ohio (the deer herd is still thriving), and it is possible that some of the occurrences represent Recent animals. Peccaries were medium-sized herd animals that must have been abundant during the Pleistocene, as they are the most abundant fossil artiodactyl known from Ohio. Peccary bones from Indian Trail Caverns represent at least 23 individuals. Twelve peccary skeletons were discovered in Columbus in 1873. The artiodactyls reported from Ohio are listed below.

**Platygonus compressus* (flat-headed peccary), numerous records in Ohio, see map.
**Cervalces scotti* (elkmoose/stag moose), Clark County, Darke County, Licking County, Stark County, Union County, Wyandot County.
**Bison latifrons* (giant-horned bison), Brown County.
Bison bison (modern bison), Adams County, Erie County, Huron County, Montgomery County, Seneca County, Warren County.
Odocoileus virginianus (white-tailed deer), Auglaize County, Columbiana County, Darke County, Erie County, Logan County, Madison County, Portage County, Wyandot County.
Rangifer tarandus (caribou/reindeer), Erie County, Logan County, Pike County, Portage County, Richland County, Wyandot County.
Cervus elaphus (elk), Darke County, Erie County, Logan County, Mercer County, Pike County, Portage County, Wyandot County.

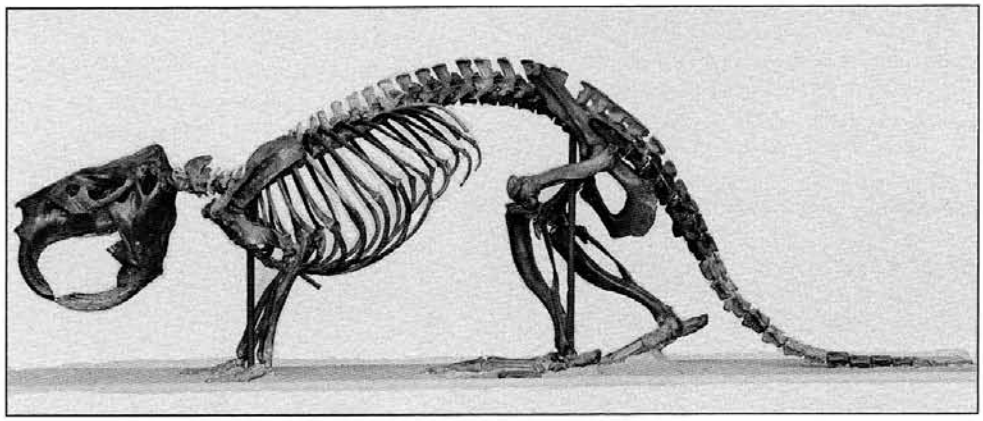


Skeleton of a ground sloth, Megalonyx jeffersoni, *displayed at Orton Museum in the Department of Geological Sciences at The Ohio State University. This specimen was discovered in Holmes County in 1890.*

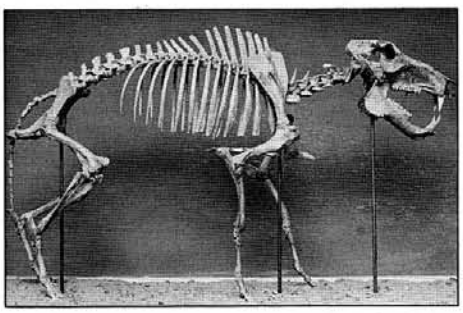
**Bootherium bombifrons* (woodland muskox), Butler County, Champaign County, Hamilton County, Trumbull County, Warren County.
Ovibos moschatus (tundra muskox), Hamilton County, Mahoning County.

Proboscidea

Two extinct elephantlike herbivores, **Mammut americanum* (American mastodon) and **Mammuthus* sp. (mammoth), are the most commonly reported Pleistocene fossils from Ohio. Remains of nearly 250 proboscideans have been recorded from 70 of Ohio's 88 counties. Most reports are represented by isolated teeth, bones, or tusks. Mastodon remains outnumber those of mammoths by a



Skeleton of a giant beaver, Castoroides ohioensis. *This extinct species was first discovered and described from Ohio in 1838. Photo courtesy of Field Museum of Natural History.*



Skeleton of a peccary, Platygonus compressus, *displayed at the Department of Geology at Bowling Green State University. This specimen was discovered in Sandusky County. Photo courtesy of R. D. Hoare, Bowling Green State University.*

ratio of about 3 to 1. About 20 percent of these proboscidean remains, mostly tusk fragments, are indeterminate as to species. No comprehensive study has been done on mammoth remains from Ohio and it is therefore uncertain at this time if more than one species is present. It is probable that most mammoth remains from the state belong to *Mammuthus primigenius,* the wooly mammoth, a common inhabitant of tundra and taiga environments. Some specimens may be referable to *M. jeffersoni,* a larger, more southerly species that inhabited prairie environments.

Carnivora

Remains of Pleistocene carnivores are rare in Ohio—all but one specimen have come from either the Carter site in Darke County or the Indian Trail Caverns site in Wyandot County. It is probable that the dire wolf (*Canis dirus*) and a sabertooth cat (*Smilodon fatalis*) were present in Ohio, as they have been found in nearby states. The carnivores identified from Ohio are listed below.

**Arctodus simus* (short-faced bear), Indian Trail Caverns.

Ursus americanus (black bear), Indian Trail Caverns.

Ursus arctos americanus (grizzly bear), Butler County.

Procyon lotor (raccoon), Indian Trail Caverns.

Mustela erminea (weasel), Indian Trail Caverns, Carter site.

Martes americana (pine marten), Indian Trail Caverns, Carter site.

Martes pennanti (fisher), Carter site.

Mustela vison (mink), Carter site.

Mephitis mephitis (striped skunk), Indian Trail Caverns.

ACKNOWLEDGMENTS

We thank Dr. H. Gregory McDonald of the Cincinnati Museum of Natural History for his assistance with this article. We also thank Mr. Richard Hendricks of Indian Trail Caverns for his assistance and hospitality.

FURTHER READING

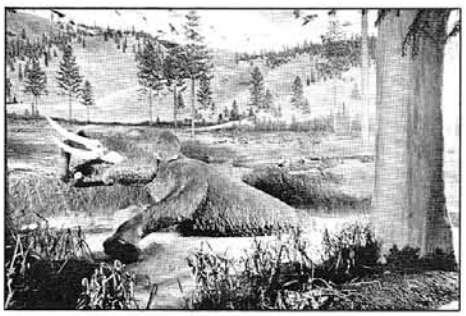
Forsyth, J. L., 1963, Ice Age census: Ohio Conservation Bulletin, v. 27, no. 9, p. 16-19, 31, back cover.

Hay, O. P., 1923, The Pleistocene of North America and its vertebrated animals from the states east of the Mississippi River and from the Canadian provinces east of longitude 95: Washington, D.C., Carnegie Institution Publication No. 322, 499 p.

Martin, P. S., and Klein, R. G., 1984, Quaternary extinctions: University of Arizona Press, 892 p.

ICE AGE EXHIBIT OPENS AT CINCINNATI MUSEUM OF NATURAL HISTORY

On November 2, 1991, the Cincinnati Museum of Natural History opened its premier exhibit in the new facilities at Union Terminal, a spectacular Art Deco style building constructed in 1933 as Cincinnati's railroad station. This exhibit, which has been in the planning stages since 1978, focuses on the Pleistocene Ice Age and provides visitors a life-size walk-through of a glacier and animals as they may have appeared in the Cincinnati area about 19,000 years ago. Mastodon, peccaries, sabertooth cats, dire wolves, ground sloth, giant beavers, elk-moose, and numerous small animals are represented by full-size fiberglass reconstructions that are so detailed and lifelike that they appear to be living creatures. Each animal is surrounded by landscape reconstructions that accurately portray the habitat of a particular species. The snout of a glacier is accompanied by gushing meltwater and a blast of cold air. Complementary exhibits adjacent to the Ice Age walk-through offer explanations of life habits of these animals.



View of a mastodon trapped in a bog in the new Ice Age exhibit at the Cincinnati Museum of Natural History.

The reconstructions of the Pleistocene animals were made by the art staff of the Cincinnati Museum of Natural History under the direction of Dr. H. Gregory McDonald, Curator of Vertebrate Paleontology. Each animal was first sculpted in clay at a scale of 2 inches represents 1 foot. A plaster model was made from a cast of the clay model and cut into sections. Each section was enlarged to full size on a grid, from which plywood sections were made to form the body support of the animal. Wire was shaped on the plywood supports to form the general body of the animal. Modeling clay was used to form the exact body of the animal, including minute details such as hair patterns and even battle scars on the female sabertooth cat. The life-size clay model was coated with latex rubber to form a mold, from which a fiberglass cast could be made. Artists then applied the finishing touches, which included detailed painting of the models. At each stage each animal was carefully scrutinized for scientific accuracy. Most of the animals took months to complete.

This exhibit is unique and will enthrall even the most casual visitor. It gives viewers a real sense of entering a time tunnel and stepping back into the Late Wisconsinan Ice Age as it was in Ohio. The Cincinnati Museum of Natural History at Union Terminal is open from 9:00 a.m. to 5:00 p.m. Monday through Saturday and from 11:00 a.m. to 6:00 p.m. on Sunday. For further information, please call 513-287-7000.

SURVEY STAFF CHANGES

COMINGS

Allen G. Axon, Geologist, Mineral Resources and Geochemistry Section.

GOINGS

Henrietta Gaskins, Environmental Technician, Subsurface Stratigraphy and Petroleum Geology Section, to Division of Water.

Toni McCall, Word-Processing Specialist, Regional Geology Section, to Division of Reclamation.

Patricia A. Nicklaus, Public Inquiries Assistant, Subsurface Stratigraphy and Petroleum Geology Section.

Joel D. Vormelker, Geologist, Regional Geology Section, to Division of Water.

James Wooten, Geology Technician and Core Librarian, Subsurface Stratigraphy and Petroleum Geology Section, to retirement.

MATHER MEDAL AWARDED TO WAYNE D. MARTIN

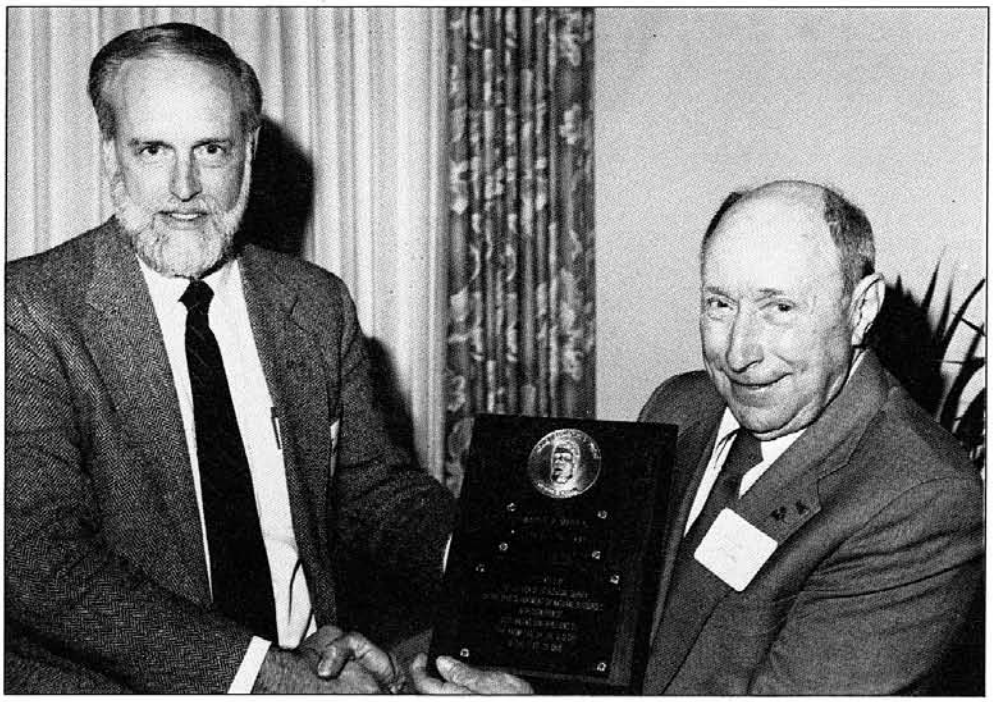
Dr. Wayne D. Martin, Professor Emeritus of Geology at Miami University, was awarded the Mather Medal of the Ohio Geological Survey in ceremonies held on October 14, 1991, at the Faculty Club of The Ohio State University. This award recognizes significant, lifelong contributions to the knowledge of the geology of Ohio and is named after Ohio's first State Geologist, William W. Mather (1837-1838).

The medal was presented to Dr. Martin by Division Chief and State Geologist Thomas M. Berg at a special dinner held in conjunction with the Bownocker Lectures, sponsored by the Department of Geological Sciences of The Ohio State University. Adolf Seilacher of Tubingen University was the Bownocker Lecturer and an honored guest at the Mather Medal dinner.

The Mather Medalist is selected by the Mather Medal Committee of the Survey from nominations submitted by Survey staff. Each member of the committee serves a three-year term. The 1991 Mather Medal Committee is composed of C. Scott Brockman (chairman), Donald E. Guy, Jr., Glenn E. Larsen, E. Mac Swinford, and Garry A. Yates. Previous recipients of the Mather Medal are Myron T. Sturgeon (1987), Richard P. Goldthwait (1989), George W. White (1989), and Jane L. Forsyth (1990).

Dr. Wayne D. Martin was awarded the Mather Medal for his significant contributions to the geology of Ohio during a 35-year career of active teaching and research in Ohio. During this time, and continuing since his retirement in 1986, Dr. Martin has written numerous papers on Ohio bedrock geology and supervised a large number of theses on various aspects of the geology of the state.

Wayne D. Martin was born in Watertown, Ohio, in Washington County, and as a boy developed an interest in geology from his exploration of nearby rockshelter caves formed in massive sandstones of the Dunkard Group (Permian). He pursued this initial interest, after serving in the U.S. Navy during World War II, by obtaining a bachelor's degree in geology at Marietta College in 1948.



Wayne D. Martin, right, receives Mather Medal from State Geologist Thomas M. Berg.

Martin then went to West Virginia University and obtained a master's degree in 1950. His thesis, *Petrology of the Upper Marietta and Hundred sandstones in southeastern Ohio,* was the beginning of Martin's formal scientific investigations of the rocks that first spurred his curiosity as a child. This curiosity continued through his Ph.D. dissertation (1955) at the University of Cincinnati, titled *The Hockingport sandstone (Late Carboniferous) of southeastern Ohio,* and continues to this day. Dr. Martin is currently preparing a summary paper on the Dunkard Group which will assimilate the results of his research and the results of 19 master's degree theses, prepared under his supervision, on these Permian rocks.

In addition to work on Permian rocks of Ohio, Dr. Martin has given his attention to Ordovician rocks in southwestern Ohio. He has written a number of papers and has supervised 12 master's theses on these rocks. Added to this research under his direction are 16 master's theses on rocks of other geologic systems in Ohio and other states.

It is obvious from the number of students who chose to do theses under Dr. Martin's direction that he was a popular and respected teacher, a career that began with a position as an instructor in geology at Bowling Green State University in 1951. In 1952, Martin began his long association with Miami University, rising through the ranks as instructor, assistant professor, associate professor, professor, and finally, professor emeritus. His skills as a field geologist were exemplified not only by his work in Ohio but also by his tenure as an instructor and director of the Miami University geology field camp in Dubois, Wyoming, from 1953 to 1986.

Dr. Martin has contributed greatly to Ohio geology through publications, lectures, and the training and direction of students. It is with great pride that the Division of Geological Survey has bestowed the Mather Medal on Dr. Wayne D. Martin.

—Michael C. Hansen

MINERAL INDUSTRIES REPORT AVAILABLE

The *1990 Report on Ohio mineral industries,* compiled by Survey geologist and mineral statistician Sherry L. Weisgarber, is now available from the Division of Geological Survey. The report provides production, sales, and employment statistics for all Ohio mineral industries, including coal, limestone/dolomite, sand/gravel, sandstone/conglomerate, clay, shale, gypsum, salt, and peat, plus production and value statistics for oil and gas. In addition, the mining activities of each mineral industry are briefly reviewed. Alphabetical and by-county directories of coal and industrial-mineral mine operators are included, as is a map of the locations of reporting producing coal mines and all industrial-mineral mines in 1990.

The 1990 report contains two articles of interest. The staff of the Briar Hill Stone

Company prepared an article on the history of their company and the art of stonecutting. Survey geologist and core-drilling supervisor Douglas L. Crowell authored an article on the drilling program's involvement with mine subsidence mitigation in Wellston, Ohio.

Copies of the *1990 Report on Ohio mineral industries* are available from the Survey for $6.54, including tax and mailing. The map is also available separately for $1.81, including tax and mailing.

OHIO'S MINERAL INDUSTRIES TEACHERS WORKSHOP

If you're a teacher who wants to learn the facts about the mining industries in Ohio, the sixth annual Ohio's Mineral Industries Teachers Workshop is for you. The workshop is conducted by the Division of Geological Survey and the University of Akron and carries 2 semester hours of graduate credit. The 1992 workshop will be held July 6-10.

The purpose of the workshop is to familiarize participants with the geology of Ohio and the development of mineral industries in the state so that teachers can more effectively communicate this information to their students. Teachers will hear representatives from research, industry, and regulatory agencies present information on the geologic origin, economics, and regulation of mineral resources in the state. Three days of field trips give teachers a firsthand look at the operations of various mineral industries in Ohio.

For more information on the 1992 Ohio's Mineral Industries Teachers Workshop, contact Dr. Roger Bain, Department of Geology, University of Akron, Akron, OH 44325-4101 (telephone 216-972-7659), or Sherry L. Weisgarber, ODNR, Division of Geological Survey, 4383 Fountain Square Drive, Columbus, OH 43224-1362 (telephone 614-265-6588).

—Sherry L. Weisgarber
Mineral Resources and Geochemistry Section

QUARTERLY MINERAL SALES, JULY—AUGUST—SEPTEMBER 1991

compiled by Sherry L. Weisgarber

Commodity	Tonnage sold this quarter[1]	Number of mines reporting sales[1]	Value of tonnage sold[1] (dollars)
Coal	6,864,478	135	$198,545,199
Limestone/dolomite[2]	14,272,911	103[3]	55,017,741
Sand and gravel[2]	12,012,133	208[3]	41,472,088
Salt	374,882	5[4]	5,826,044
Sandstone/conglomerate[2]	373,268	14[3]	6,610,925
Clay[2]	624,271	27[3]	2,366,099
Shale[2]	787,495	22[3]	1,457,186
Gypsum[2]	54,405	1	516,848
Peat	6,274	3[3]	83,869

[1]These figures are preliminary and subject to change.
[2]*Tonnage sold* and *Value of tonnage sold* include material used for captive purposes. *Number of mines reporting sales* includes mines producing material for captive use only.
[3]Includes some mines which are producing multiple commodities.
[4]Includes solution mining.

MAJOR CREDIT CARDS NOW ACCEPTED

The Survey will now accept VISA and Mastercard for purchases of publications and maps for over-the-counter sales and telephone orders. Credit cards *cannot* be used to pay for boat registrations, hunting or fishing licenses, or wetland habitat stamps, which are also sold through the Survey-operated ODNR Publications Center. Telephone orders for publications and maps should be directed to 614-265-6605.

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DIVISION OF GEOLOGICAL SURVEY

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