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THE AMERICAN MUSEUM OF NATURAL HISTORY

THE AMERICAN MUSEUM OF NATURAL HISTORY

AN INTRODUCTION

LIBRARY
OF THE
AMERICAN MUSEUM
OF NATURAL HISTORY

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The American Museum of Natural History
Central Park West and 79th Street
New York, N.Y. 10024

WELCOME. You are visiting an institution that is perhaps more influential than any other in exploring and illuminating man's precarious relationship with the natural world. It is The American Museum of Natural History, referred to by most people simply as *the museum of natural history*.

We are well over a century old, and with each passing year we get more famous and more beautiful. Maturity and growth have brought the development of imaginative programs, excursions into lively new areas of teaching and exhibition, and involvement in the most profound areas of science.

Today our research influences the world's biological thinking. Our training prepares scores of young scientists for their life's work. Our classes help urban students and teachers understand the interrelationships of nature. Our anthropology programs ensure a better understanding of the differences among human cultures. Our exhibits bring the past to life, and involve viewers in the complexity of today's environments.

Your visits to the Museum and The American Museum–Hayden Planetarium enable us to bring our programs forward. You provide funds, which are crucial. You also offer a yardstick of our success in your reactions to our exhibits, in your desire to visit again and read our publications, and in your influence on your families and acquaintances. We think you will agree that the quality of our lives is enhanced beyond measure by an appreciation for the wonders of the natural world.

Gardner D. Stout — T. D. Nicholson

Gardner D. Stout, President — Thomas D. Nicholson, Director

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(Pictures are in Parentheses)

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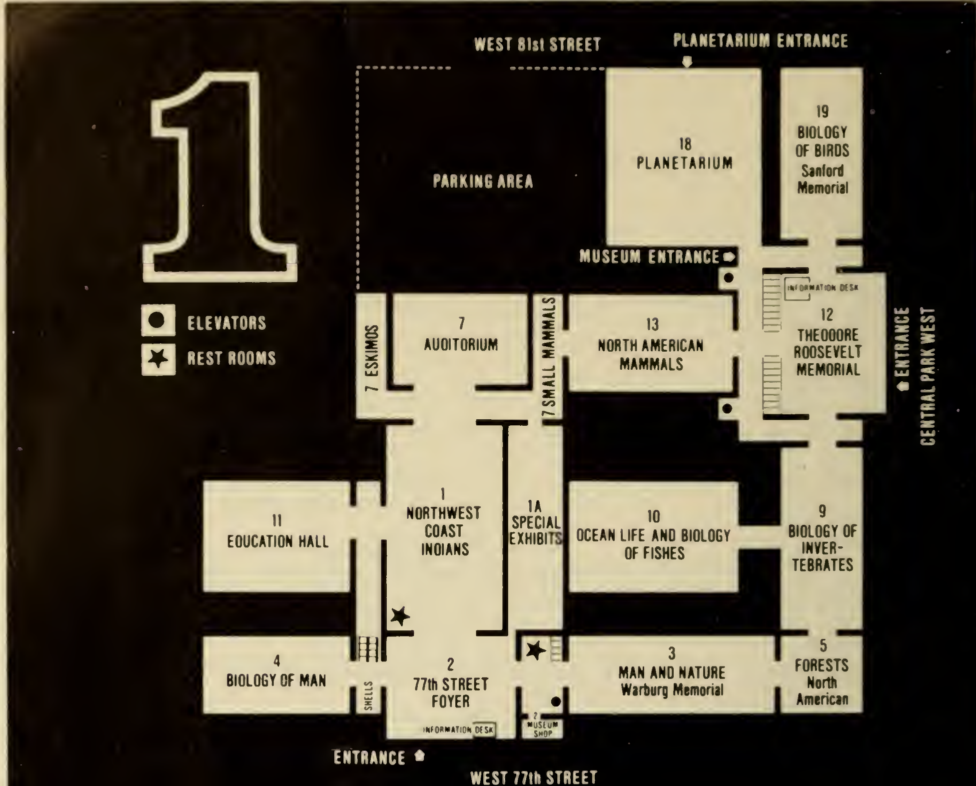

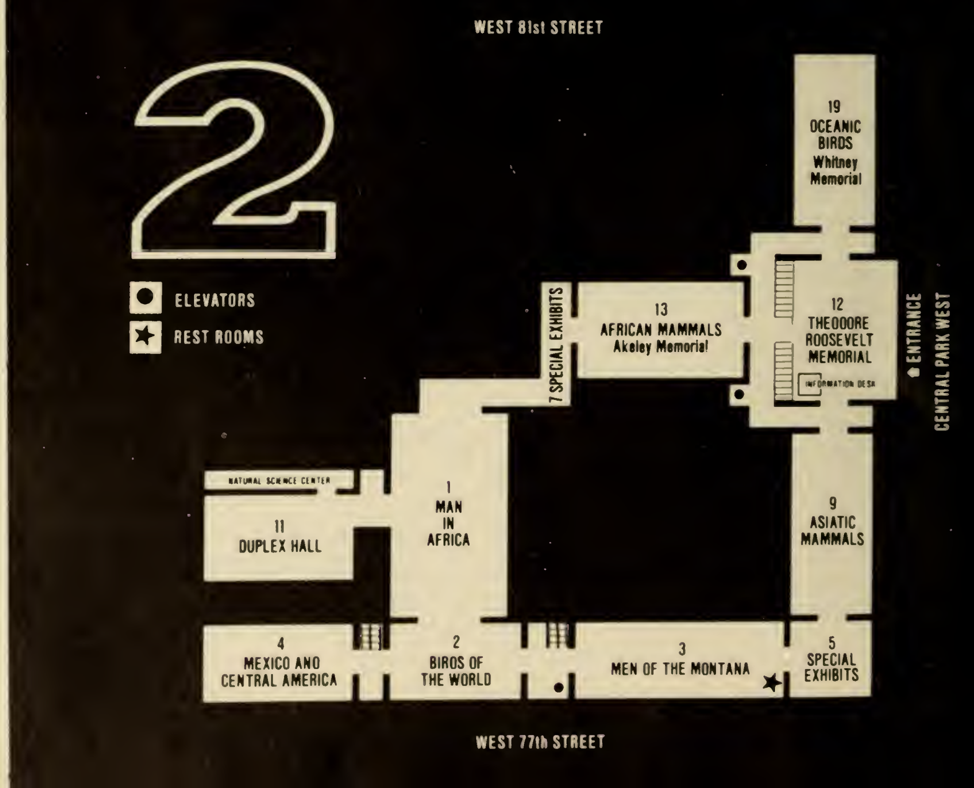


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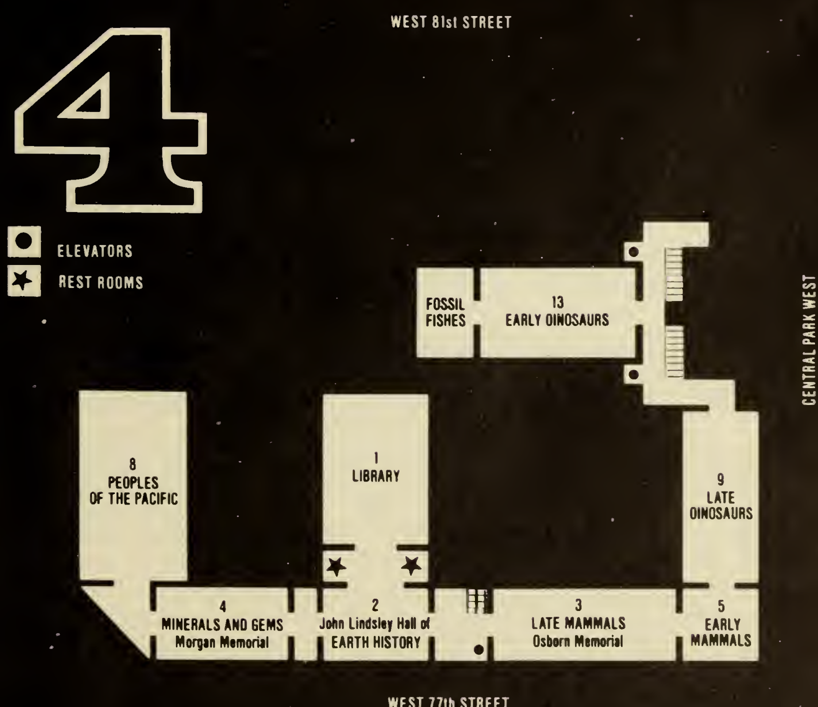
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Night view of the Central Park West entrance to The American Museum of Natural History.

INFORMATION

The American Museum of Natural History is located on the upper west side of Manhattan in Theodore Roosevelt Park, bounded by Central Park West, 81st Street, Columbus Avenue, and 77th Street. The main entrances are on Central Park West and 77th Street. There is another entrance from the parking lot at 81st Street, near The American Museum–Hayden Planetarium.

The Museum is open every day except Thanksgiving and Christmas. School groups must make reservations for visits.

Transportation

To reach the Museum by bus: the 79th Street Crosstown (No. 17) to Central Park West. Or the Eighth Avenue (No. 10) or the Columbus Avenue (No. 7 or No. 11) to 77th Street.

To reach the Museum by subway: the Independent (IND) Eighth Avenue Local (AA or CC) to the 81st Street Station. Or the IRT Seventh Avenue Local (No. 1) to the 59th Street Station and change for the IND Local (AA or CC) uptown to the 81st Street Station. Or the IRT Lexington Avenue Local (No. 6) to the 77th Street Station and then the 79th Street Crosstown bus (No. 17) to Central Park West.

To reach the Museum by car: refer to local highway and street maps. The Museum has a small parking lot on the 81st Street side, for which there is a charge, and there is limited parking on the streets around the Museum.

Telephone Information

Museum Information:	212 873–4225
Planetarium Information:	212 873–8828
Museum and Planetarium Offices:	212 873–1300

MEMBERSHIP

Membership in The American Museum of Natural History is open to everyone for a modest sum. Members of the Museum enjoy many facilities not offered to other visitors: a subscription to NATURAL HISTORY Magazine, a Members' Lounge, access to lecture series, and a whole range of practical benefits. There are also intangible benefits—the satisfaction of supporting important research in all the natural sciences, the knowledge that the educational advantages of the Museum are open to more and more people, a feeling of community with the environment as the Museum explores and explains man's relationship with his world. The Museum needs the support of its visitors if it is to continue its work, and membership is one way of giving this support.

For information on becoming a member, see the Membership Secretary (Second Floor, Section 12), the Museum Shop (First Floor, Section 2), or the Information Desks.

SERVICES

Ask an attendant for cloakroom facilities.

A cafeteria serving light snacks is located in the basement near the subway entrance. The Museum does not have facilities for picnic lunches, but School Lunchrooms are available for school groups with advance reservations.

Sketching and photography are permitted in the Museum if they do not interfere with the enjoyment and study of other visitors. Amateurs are prohibited from selling their photographs or allowing them to be used for commercial purposes. Professional photographers and filmmakers must make arrangements with the Office of Public Affairs.

Members of the Museum in their private lounge (Second Floor, Section 12).

PHOTOGRAPHY

The Division of Photography has a collection of more than 500,000 black and white negatives and thousands of color transparencies on all aspects of natural history, including Museum exhibits and dioramas. This collection and other photographic services are available to the public for a nominal fee. For information call, write, or visit the Division of Photography (Fourth Floor, Section 11).

LIBRARY

The Museum Library (Fourth Floor, Section 1) contains more than 275,000 books and periodicals on natural history and is considered one of the finest in the world. It has volumes covering every subject from anthropology to zoology, as well as maps and books on travel and exploration. The Library has an exceptional collection of rare books on natural history; many of them are first-edition monographs and folios of great value. The Library is open to the public for research; for days and hours see the librarian.

The Osborn Library of Vertebrate Paleontology, which is separate from the main library, is not open to the public, but certain volumes can be obtained on request through the Museum Library.

SHOPS

The Museum Shop

The Museum Shop is located off the 77th Street Foyer (First Floor, Section 2). There is a wide selection of merchandise, and proceeds from sales are

Habitat group of white-tailed deer in the Roosevelt Memorial (First Floor, Section 12), photographed by the Division of Photography.

Examples of the artifacts and reproductions available in the Museum Shop (First Floor, Section 2).

Left, a Hopi Kachina doll; center, a Peruvian llama; right, a fertility doll from Ghana.

used to further the research and educational activities of the Museum. There are handsome reproductions of some of the fine art objects in the Museum's collections, authentic American Indian jewelry and pottery, and many unusual and sometimes rare examples of handmade pieces from distant places reflecting many different cultures. A large selection of books in the natural sciences is available for both adults and children.

The Junior Shops

The Junior Shops are located in the 77th Street Foyer (First Floor, Section 2) and on the lower level of the Roosevelt Building (Basement, Section 12). The areas feature small dinosaur models, compasses, microscopes, ethnic dolls, and a large selection of postcards showing many of the spectacular dioramas and habitat groups in the Museum. There are many mineral specimens and rock collections, as well as books with which to study them.

The Planetarium Shop

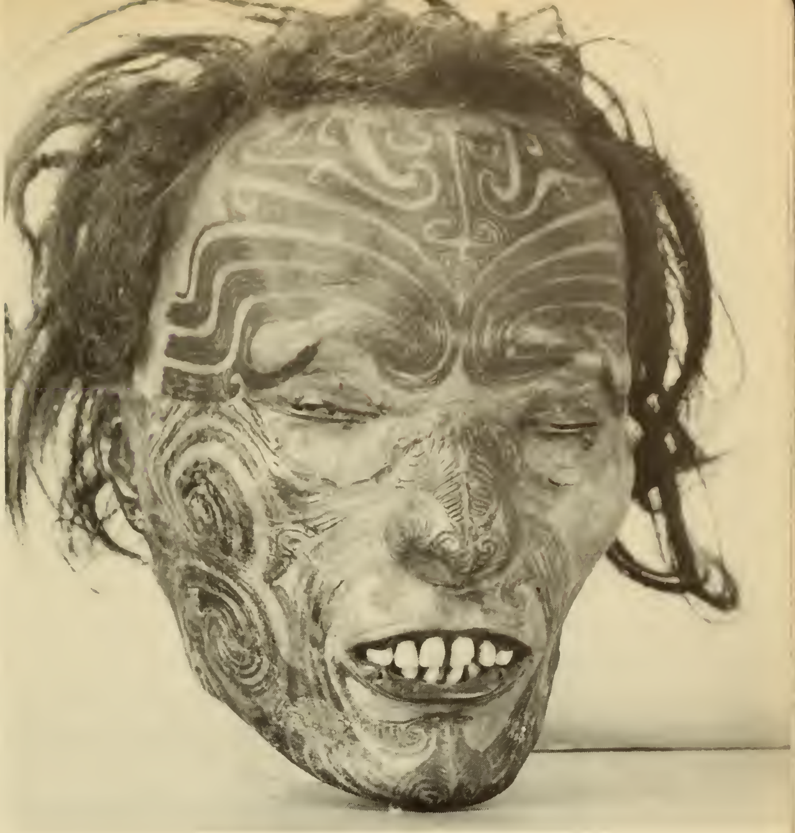
The Planetarium Shop is located near the main entrance to the Planetarium on 81st Street (First Floor, Section 18). It sells sky charts, moon maps, star identification guides, astronomy art, and telescopes. There is a wide selection of books on astronomy and space for both adults and children. For younger visitors, educational space-related knicknacks and toys are available, as well as such novelties as small meteorites and tektite specimens.

HIGH SPOTS IN THE MUSEUM

94-foot Blue Whale It dives head-first from the ceiling of the Hall of Ocean Life and Biology of Fishes. It's the largest of all animals, and a beautiful member of the kingdom (First Floor, Section 10).

Birth of a Baby How human children are born, and how they are put together. Man is a mammal, too, and he has a hall devoted exclusively to his origins and biology. Hall of the Biology of Man (First Floor, Section 4).

Dodo bird, now extinct, is shown in the Hall of the Biology of Birds (First Floor, Section 19).



Dried head from New Zealand in the Hall of the Peoples of the Pacific (Fourth Floor, Section 8).

Gold of the Americas What the Europeans came for. Today gold means wealth, but to the Central and South American Indians who fashioned these lovely objects, the significance was religious and ornamental. Hall of Mexico and Central America (Second Floor, Section 4).

African Ceremonial Dress Religions, secret societies, tribal cults—their rituals in Africa inspired some of the most fascinating apparel ever made. Hall of Man in Africa (Second Floor, Section 1).

African Elephants A thrilling sight in the wild, and no less so in The American Museum of Natural History. A herd of eight on the run, with a protective young male defending the rear. Akeley Memorial Hall of African Mammals (Second Floor, Section 13).

Tyrannosaurus Rex One of the great dinosaurs now gone but not forgotten. Millions of children and former children visit the Museum just to see the dinosaurs. Halls of Dinosaurs (Fourth Floor, Sections 9 and 13).

Star of India It is one of the world's finest sapphires (563 carats) and, like many great gems, it has a fascinating history. Morgan Memorial Hall of Minerals and Gems (Fourth Floor, Section 4).

Maori Tattooed Heads Severed, decorated, and dried, the heads were prepared by friends of the deceased. Hall of the Peoples of the Pacific (Fourth Floor, Section 8).

PUBLICATIONS

Along with its many other activities, The American Museum of Natural History is a publisher. Its technical publications, well known to biologists, geologists, and anthropologists around the world, contain research reports appearing in print for the first time. Its popular publications cover all aspects of natural history and are seen by a wide audience that includes both scientists and laymen. The Museum's publications include:

Anthropological Papers A journal devoted to discoveries and explorations, covering such topics as ethnology, physical anthropology, and related anthropological subjects.

Bulletin A series of technical publications recording the research of scientists in the field and in the laboratory, as well as the results of expeditions. The publications report on ten disciplines, including entomology, geology and paleontology, herpetology, ichthyology, mammalogy, ornithology, marine biology, malacology, and animal behavior.

Novitates A small, well-illustrated serial publication reporting the results of preliminary experiments, first accounts of expeditions, and detailed descriptions of new forms in systematics in all of the subjects of the *Bulletin*.

Dean Bibliography of Fishes A yearly, computerized analysis of significant literature put out by the Museum's Department of Ichthyology as a service to the world's ichthyologists.

Herpetological Review An international newsletter produced by the Museum's Department of Herpetology for the Herpetologists League and the Society for the Study of Amphibians and Reptiles. It includes *Current Herpetological Titles*, a computerized list of the current literature.

Micropaleontology A quarterly journal published by the Micropaleontology Press of the Museum's Department of Invertebrate Paleontology. The press, a prime source of geological information in fuel production, also publishes catalogs of one-celled animals and certain crustaceans, a monthly bibliography, and an index of micropaleontology literature.

Curator A quarterly journal for the museum profession that serves as a forum for all aspects of modern museology, from the preparation of fossil specimens to the role of a museum in present society.

Calendar of Events A bimonthly brochure describing current exhibits, activities, films, lectures, and educational offerings for adults and children.

Annual Report A color magazine discussing each year's activities at the Museum —including openings of new exhibits, special events, and outstanding research.

Books The Museum is actively involved in publishing books of many kinds, from catalogs of exhibits to collections of articles from NATURAL HISTORY Magazine to books concerning the natural sciences.

NATURAL HISTORY

For more than 70 years The American Museum has published NATURAL HISTORY, a popular magazine concerned with the life sciences, anthropology, and astronomy. It has a nationwide circulation of more than 300,000.

The magazine is edited in offices at the Museum, but experts throughout the world discuss their investigations and conclusions in its pages. Members of the Museum's scientific staff often contribute articles to NATURAL HISTORY, and they review many of the magazine's manuscripts for accuracy. The articles are accompanied by illustrations, with many full-color photographs usually taken in the field.

Each issue contains articles about wildlife, such as the predators of the Serengeti, the mysterious mountain lions of North America, or the invasion of the Western Hemisphere by the cattle egret; modern anthropological articles, such as devil worship by Bolivian tin miners or recent archeological discoveries in mainland China; astronomy or geology articles on such topics as the expanding universe or earthquakes; and a series of thought-provoking columns, essays, and book reviews covering a wide range of human and ecological subjects.

While several thousand copies of NATURAL HISTORY are sold in shops at The American Museum of Natural History and other museums throughout the country, most readers obtain the magazine by becoming members of the Museum. In addition to a subscription to the magazine, members receive other benefits within the Museum. At the same time they contribute to the support of one of the world's leading scientific organizations.

To subscribe, write to: Natural History, P.O. Box 2925, Boulder, Colorado 80302, or inquire at the Museum Shop or the Information Desks. For information on higher classes of membership in The American Museum, see the Membership Secretary (Second Floor, Section 12).

MUSEUM BUILDINGS

At first glance, The American Museum of Natural History is a collection of large, pink and white buildings topped by towers reminiscent of those found on fairy-tale castles. One of New York City's largest cultural structures, the Museum was declared a landmark by the Landmarks Preservation Commission in 1966.

Closer study reveals the many different architectural styles used in building the Museum. On approaching the 77th Street entrance, visitors find a handsome building with a Romanesque Revival facade facing south and extending from Columbus Avenue to Central Park West.

The main motif of the five-story facade, which is made of Vermont pink granite, is two central stairways rising from the street to a seven-bay, arcaded porch at the second-floor level of the Museum. The stairways are located on either side of a giant, segmental arch, formerly the carriage entrance and now part of the 77th Street entrance. The porch terminates at both ends with two of the Museum's well-known towers, which rise well above the rest of the structure.

If the visitor stands in front of the entrance and looks up at the building he cannot detect the original South Central Wing. Built in the Victorian-Gothic style and completed in 1877, it is concealed by the 77th Street facade. Neither can he see the newest addition to the Museum, the Childs Frick Wing, which was completed in 1971. This modern structure was built in an interior courtyard behind and to the side of the central portion of the facade. Ten stories tall, it is designed to hold the world's largest collection of fossil mammals and is available for research only.

The main entrance to the Museum on Central Park West is formed by the Theodore Roosevelt Memorial, which has a Roman triumphal arch motif. The building is approached by a broad flight of stairs leading to the arch. Deeply recessed within the arch is the doorway, with its enframed bronze doors and ornate frieze. On either side of the arch are two free-standing Ionic columns. The gray limestone building was erected in memory of the twenty-fifth president of the United States by the people of New York State. It was dedicated in 1936 by President Franklin D. Roosevelt.

The American Museum–Hayden Planetarium, a highly recognizable landmark in its own right, was completed in 1935. The Whitney Wing, which houses the bird collections and laboratories, was opened in 1933.

THE PAST

The American Museum of Natural History was founded by Albert Smith Bickmore in 1869 for the purpose of advancing the study and teaching of the natural sciences. The Museum opened in 1871 in the old Arsenal Building in Central

Aerial view of the Museum in the 1970s. Central Park is at lower right; Columbus Avenue at upper left.

First unit of the Museum in 1877. The Columbus Avenue elevated railroad is at left; Central Park is just visible at right.

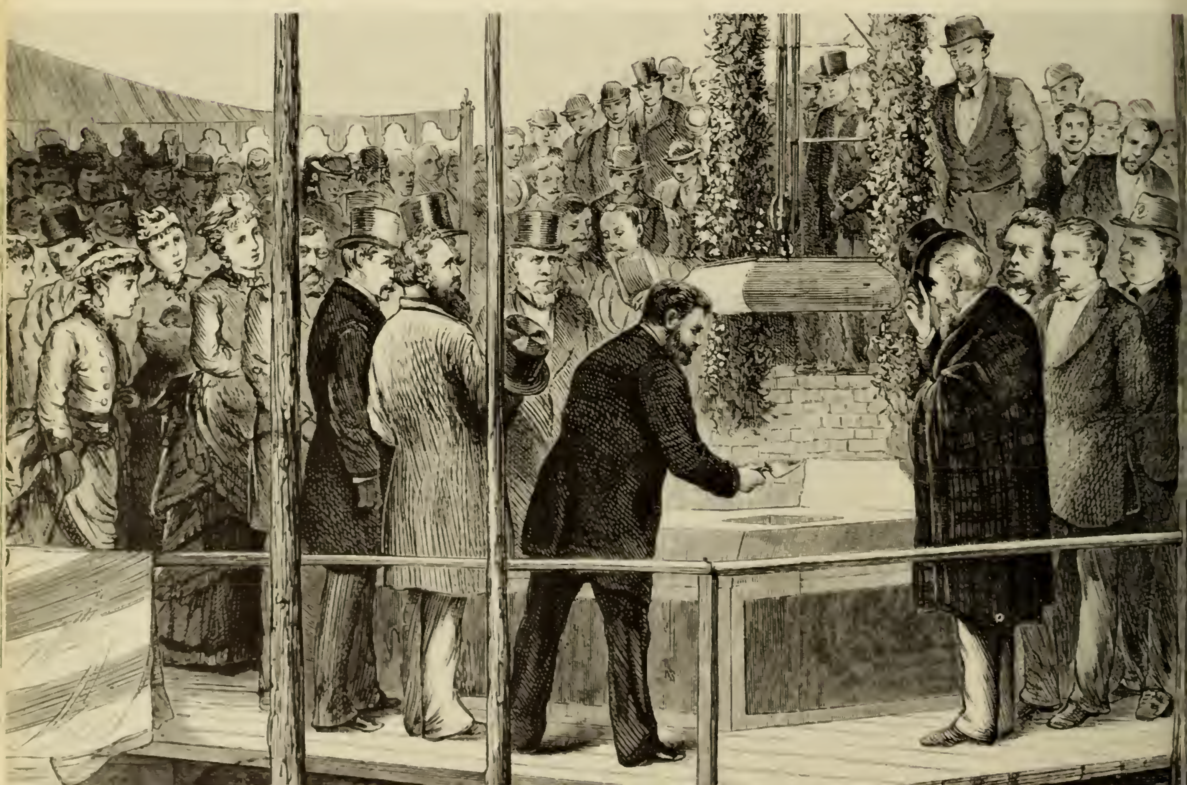
Park, which was its home until 1877. In the intervening years the plans for the present site were developed. The eighteen acres of Manhattan Square were designated by New York City as the future home of the Museum. Calvert Vaux, one of the designers of Central Park, planned the Museum as a splendid castle in what was then a wilderness. Farms and swamps abounded; there were a few inhabited shanties. Harlem was a tiny settlement to the north, and stagecoaches were the only means of transportation to the Museum area.

The cornerstone for the first unit of the new Museum was laid by President Grant in 1874. (For years no one knew where the cornerstone had been laid—it was finally found in 1968.) The Museum was formally opened in December 1877, when President Hayes and a group of distinguished citizens came to lavish opening ceremonies. The Museum grew—the second unit was finished in 1892, the entire 77th Street structure was completed by 1900, and sections were added throughout the 1900s.

As the number of halls increased, so did the collections. The first major acquisition was a great collection of mammals, birds, reptiles, and amphibians purchased from Prince Maximilian of Weid in 1869. The renowned fossil collection of Professor James Hall was obtained in 1873. P. T. Barnum contributed an iguana and "one Human Hand." Other collections were bought or donated.

The Museum began to look beyond Manhattan Square in its quest for

President Grant laying the cornerstone of the Museum on June 2, 1874 (from *Frank Leslie's Illustrated Newspaper*).



research materials and specimens. In 1887 the first of over a thousand exploring parties left the Museum—an expedition to the badlands of Montana in search of bison. Other expeditions brought back a wealth of material—both specimens for study and exhibit and information for research. The Museum's largest expedition, led by Roy Chapman Andrews in 1923, traversed 2200 miles of hitherto unexplored wastes in the Gobi Desert and returned with the Museum's celebrated fossil dinosaur eggs.

Asia, the Arctic, the South Pacific, Africa—all have been visited by scientists in their search for knowledge. Some of the Museum scientists gained public renown, such as Henry Fairfield Osborn, the paleontologist, Frank Chapman, the ornithologist, and Margaret Mead, the anthropologist.

The Museum had been founded at precisely the right time in history. The teachings of Darwin had opened man's mind to the order of nature, and technology had made worldwide exploration feasible. The primitive peoples were still largely unaffected by western influences, the fossil beds had not yet been destroyed to make way for mines and superhighways, and the territories of animals had not been encroached on by man's "civilization." People from the Museum joined in the exploration of the world, and the result was the rich collection of artifacts and specimens now maintained, studied, and—in some cases—exhibited at The American Museum of Natural History.

Children in the early 1900s looking at bird habitat group.

THE PRESENT

Today the Museum is a vibrant place, full of movement and activity, ideas and information—an influential voice expressing its concern for the interdependence of all life on earth, including man. Thus the theme for the Museum's Centennial in 1969: "Can Man Survive?" Over one hundred years of careful research have put the Museum in a leading position to ask such a question.

This is one of the largest museums in the world. As many as four million visitors a year come to the Museum, and many more keep in touch through NATURAL HISTORY Magazine, the communications media, and traveling exhibits.

The Museum's broad scope of activities is supported by a variety of sources, but the largest single source is the generosity of private citizens—ranging from such large amounts as a $6,000,000 gift to endowment early in the century to thousands of smaller contributions that come in annually. Private foundations and corporations are also helpful sources of funds.

The City of New York is the Museum's landlord and supplies an important share of operating expenses. Federal agencies, such as the National Science Foundation, support a number of specific research programs. The New York State Council on the Arts has also recently given assistance to the Museum.

In spite of all this support, rising costs and increasing demands on facilities have resulted in an admission charge to the public, the proceeds of which are used directly for new exhibits. Like so many other cultural institutions, the Museum must explore every avenue of potential support if it is to survive.

The Museum is under the overall control of a forty-five member Board of Trustees, elected for five-year terms. The trustees elect a President, who formulates policy under their guidance. They also appoint a Director, who administers the staff and programs of the Museum. There are 650 employees of the Museum, ranging from scientists and exhibit preparators to writers, electricians, teachers, painters, and telephone operators—all of whom are highly skilled in their fields.

Staff members in the Museum answer questions relayed from radio stations during a special program on the first Earth Day.

Field trips are essential to scientific research. Here a department head photographs shrimp.

Scientific Work

Scientific work is carried out both in the field and in the laboratories of the Museum, with some 380 research projects being conducted by 100 scientists and their assistants.

The scientific departments are Animal Behavior, Anthropology, Astronomy, Entomology, Herpetology, Invertebrate Paleontology, Ichthyology, Living Invertebrates, Mammalogy, Mineralogy, Ornithology, and Vertebrate Paleontology. Many of these departments are concerned with the work for which the Museum is famous—systematic zoology, the classification of animals and the study of their evolutionary and ecological relationships. The Museum is also well known for its research in animal behavior, mineralogy, and anthropology.

Much of the work is based on collections that have been gathered and catalogued over a period of many years. The material—some twenty-three million objects and artifacts—is acquired by the curators on field trips, and also through gifts, exchanges, and purchases.

While acquisitions continue to be made, Museum scientists going into the field today concentrate much more on observations and actual field research. Their field trips take them to many parts of the world, but most frequently to the Museum's own research stations.

Scientist offers instruction at West Side Day, an annual program for people in the Museum's neighborhood.

Field Stations

The Museum has five field stations in various parts of the Northern Hemisphere, each with special advantages for field research that attract museum curators, visiting scientists, and students. At two of the stations, the Lerner Marine Laboratory and the Southwestern Research Station, formal course programs are held for college students interested in field biology.

The Archbold Biological Station, in Lake Placid, Florida, is a 1060-acre preserve located just north of the Everglades. It presents a unique opportunity for scientists to study the fauna, flora, and ecology of some especially interesting habitats that once existed throughout Florida and a large part of the southern United States.

Great Gull Island, far out in Long Island Sound, is the nesting site for thousands of common terns and roseate terns. As such, it allows ornithological observers to study the breeding behavior, migrating patterns (through banding), and physiology of these birds.

The Kalbfleisch Field Research Station, in Huntington, Long Island, is the site for a number of long-term studies of birds, fishes, small mammals, amphibians, and vegetation. The research in progress there, mainly conducted in the summer, gives college science majors a chance to work outside of a class structure under the direction of Museum scientists.

The Lerner Marine Laboratory, on the island of Bimini in the Bahamas, is located between the shallow, coral-filled waters of the Great Bahama Bank and the deep, swift water of the Gulf Stream. As a result, there are some 500 species of fish around Bimini, as well as many other species that pass through in migration. This diversified environment enables researchers to study a wide range of sea life.

The Southwestern Research Station, near Portal, Arizona, is a fifty-three-acre preserve, surrounded by a large area of forest and desert land. Within this region there is unusual variation in altitude, temperature, vegetation, and animal life. Scientists and their students from all parts of the United States visit the station to collect specimens and conduct field studies with the sophisticated facilities and equipment housed there.

Birds are banded and released at one of the Museum's field stations, Great Gull Island, in Long Island Sound.

Education

EDUCATION

The functions of the Education Department range from offering college credit courses each semester for New York City teachers to instructing thousands of pupils who come to the Museum for special programs. Most visitors know that instructors teach individual classes of elementary and junior high students by appointment, that an auditorium program is available, and that slide lectures, film programs, and gallery talks are presented weekly throughout most of the year. However, few visitors realize that the Education Department helps local schools design their own natural science centers, that it occasionally sends lecturers to drug rehabilitation centers, or that it assists small community museums with technical advice. With a full-time teaching staff of twenty supported by more than a hundred part-time and volunteer workers, the department is quite different from the original one-man lecture service begun in 1884.

Frog is observed in the Natural Science Center, where children learn about the animals of the New York area (Second Floor, Section 11).

Members of an adult education seminar study a celestial sphere.

Brochures describing most programs are available at the Museum information desks or by writing to the Registrar in the Department of Education.

The department operates the Natural Science Center For Young People (Second Floor, Section 11), which introduces city youngsters to the wildlife and geology of the metropolitan area. The Center's atmosphere is informal, and exhibits include living plants and animals. Classes and groups must arrange in advance to visit, but the Center is open to the visiting public weekday afternoons (except Monday) and on weekends. A new special teaching area about peoples of the world has opened near the Natural Science Center; it is open afternoons and on weekends to visitors.

Guide service is available for groups. Reservations must be made in advance, and fees are scaled in accordance with the size and nature of the group. This service is presently available only on weekdays.

The department maintains a collection of exhibits and specimens that are loaned to New York City schools. Such outreach programs bring Museum facilities to a large number of people. Instructors, particularly during the summer, carry teaching into the community, participating in street fairs, block parties, and at senior citizen centers.

Field study group at a pre-Columbian temple in Mexico.

For adults, one of the most popular events is attending the Museum evening lecture series given in spring and fall. These lectures are presented by education staff as well as by curators from the scientific departments and specialists from outside. The department also offers field study tours ranging from Mexico to the American Southwest, weekend field trips in the metropolitan region, and short morning walks in some of the city's parks. These are all described in available brochures.

The department is concerned with providing visitors with assistance in the exhibition halls. To achieve this, programs have been established where interns and volunteers now serve as teaching-guides in several halls.

Even this brief description communicates the diversity of the department's functions, from adult to child-oriented teaching, from semester-long courses to single-contact situations, from a Mexican field trip to a morning walk in Central Park. The Education Department is deeply involved with what is happening in the city and what is happening in the Museum. It tries to bring the two together through its programs.

Exhibition

EXHIBITION

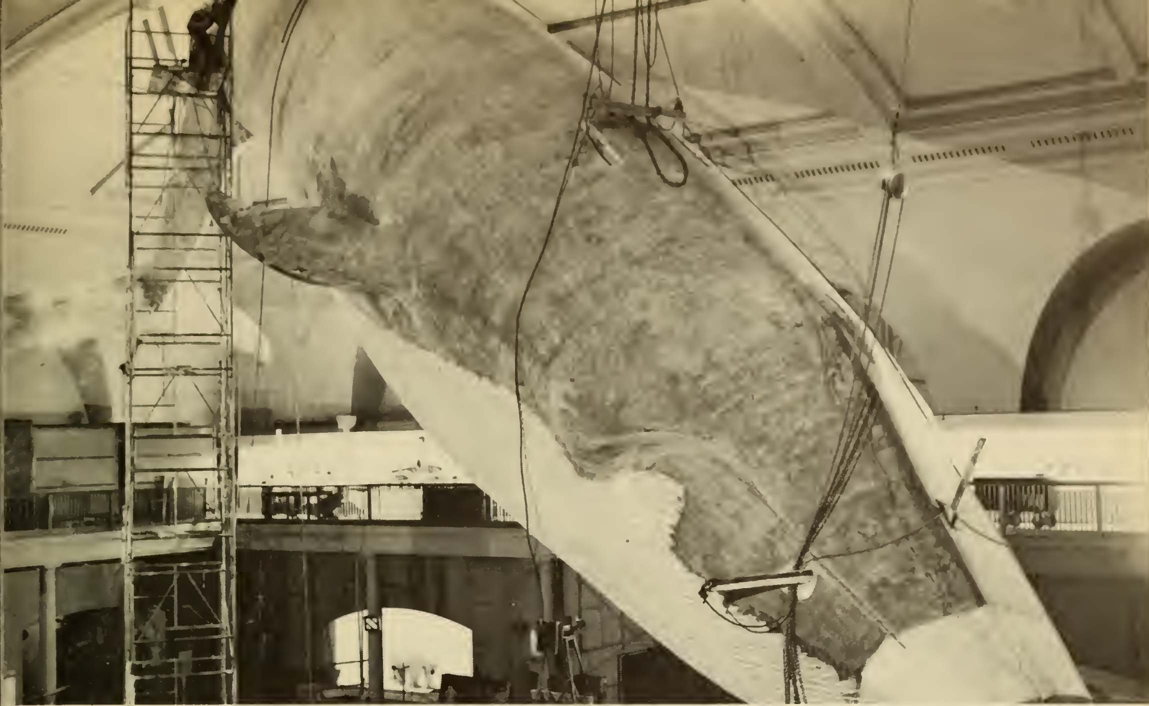
Within the Museum there are exhibition halls that date back to the 1890s and those that were opened only last year. New halls will be opened in the mid-1970s, and planning is now taking place for exhibits far in the future.

The Department of Exhibition and Graphic Arts is responsible for all of these displays, which, in addition to the permanent exhibition halls, encompass many different kinds of temporary and special exhibits. New acquisitions are often put on display before being incorporated into the Museum's collections. Timely exhibits on conservation are frequently mounted, and notable scientific discoveries are explained and interpreted as part of the Museum's function of keeping the public informed.

The techniques and skills involved in making all these exhibits, whether they last only a month or, hopefully, a lifetime, embrace the whole field of display from taxidermy to industrial design. However, some of these skills are unique to the Museum, and nowhere is this more true than in the great halls of habitat groups. Because of widespread interest in how such dioramas are constructed, the following description of the making of a typical habitat group is included in this guide.

Most habitat groups represent a specific place at a specific time of the year, so a field trip to the selected location is the first step in building the group. Innumerable sketches and color transparencies are assembled to make a complete pictorial record of the site. Samples of all plant life are collected for reproduction in the Exhibition Department studios, while soil, rocks, grasses, and other material that can be used as found are carefully labeled and crated. Whole trees may sometimes be sent back to the Museum in numbered sections.

Elephant hide is spread flat for cleaning before being mounted on a plaster mannikin.



Sections of the polyurethane and fiberglass blue whale are hoisted into place in the Hall of Ocean Life (First Floor, Section 10).

Sections of a Douglas fir tree are put together for display in the Hall of North American Forests (First Floor, Section 5).

When the artist returns from the field trip, he starts to rough out his picture on the double-curved background of the diorama, using the sketches and slides made at the site. Because there are no corners, an illusion of depth and perspective is possible in a way that could never be realized with a flat surface. This rough sketching is then transformed into a careful charcoal rendering of the scene, which is shellacked before painting begins.

In the meantime the preparator, who accompanied the artist on the field trip, organizes the material he collected. Some plants can be used as they grow in nature; these include mosses and members of the pine family, as well as grasses. They are soaked in a solution of formaldehyde and glycerine, which preserves the material and also prevents it from drying out. This treatment often makes the natural color fade, but even if it does not, colored lacquer is sprayed on, because all such preserved plant life loses its natural hue over the years.

Deciduous plants must be artificially reproduced. Molds are made from the leaves and flower petals of the plants, which were carefully preserved in the field. These molds are the basis of the vacuum-press forming in plastic sheet of the plants in the newer habitat groups. Hundreds of perfectly formed leaves, complete to every vein, can be produced at one time by this method. They are then trimmed and painted, ready for the iron wire midribs to be attached. Bundles of iron wire are dipped into nitric acid, which drips down and tapers the wires toward their ends. Older dioramas have plants made of crepe paper and wax, a time-consuming technique that needs much hand-embossing.

Other preparators work on the foreground or terrain. Again working from sketches and photographs made at the site, they cut wooden forms to match the contours of the land. These forms are covered with heavy wire netting, then burlap and plaster-of-paris, to form the foundation for the earth, plant, and animal life.

Some rocks that exist in the field may be too heavy either to transport or to install in the diorama; artificial rocks are then used. They are also made from wire netting, burlap, plaster-of-paris, or pâpier maché. After they have been painted, a "wet" surface can be obtained by running shellac or varnish down the sides.

A critical problem is the "joining" of the background painting to the foreground material. The three-dimensional plant life near the background wall is continued on the painted canvas to blend as perfectly as possible. Skill with lighting is needed here, as no shadows can be allowed to fall on the background. Careful lighting is important for all groups, especially those reproducing a sunlit scene. No matter how skillful the lighting is, however, duplication of shadows cast by the sun is rarely possible. The solution is to paint out the shadows cast by the light bulbs and to paint in the shadows where the sun would cast them. No wonder an accurate record of the site is necessary!

The mounted animals are generally installed toward completion of the group, unless they are near the back of the terrain, with plant life partially obscuring them. Only birds and small mammals are mounted by putting their skins on artificial bodies made of wrapped excelsior (the method incorrectly referred to as "stuffing").

The larger mammals are mounted on mannikins, using the sculpture technique pioneered by Carl Akeley. The basic skeleton is reinforced by a wood and wire framework that can pose the animal in the position desired. After the skin or hide is carefully removed, the flesh and muscles are replaced by watered clay, sculptured over the skeleton. The clay is shaped to match the muscles, tendons, ribs, and prominent veins, as if the animal had just lost its skin. When the statue is finished, a plaster mold is made from the clay figure. From this mold a hollow mannikin cast is made, upon which the hide is to be placed.

Working on a clay model of an Alaskan brown bear for the Hall of North American Mammals (First Floor, Section 13).

Hundreds of dinosaur bones have been identified and await assembly.

Fitting the skin to the mannikin is a delicate process. Adhesive is put on the underside of the skin as the different pieces are fitted. The pieces are also sewn together, where necessary, on the underside, and stretched tight around key points with hundreds of small nails. When the adhesive has set in two or three days, the nails are removed, and the contours of the body, the ribs, and the rippling muscles are as plain as they would be in a living specimen.

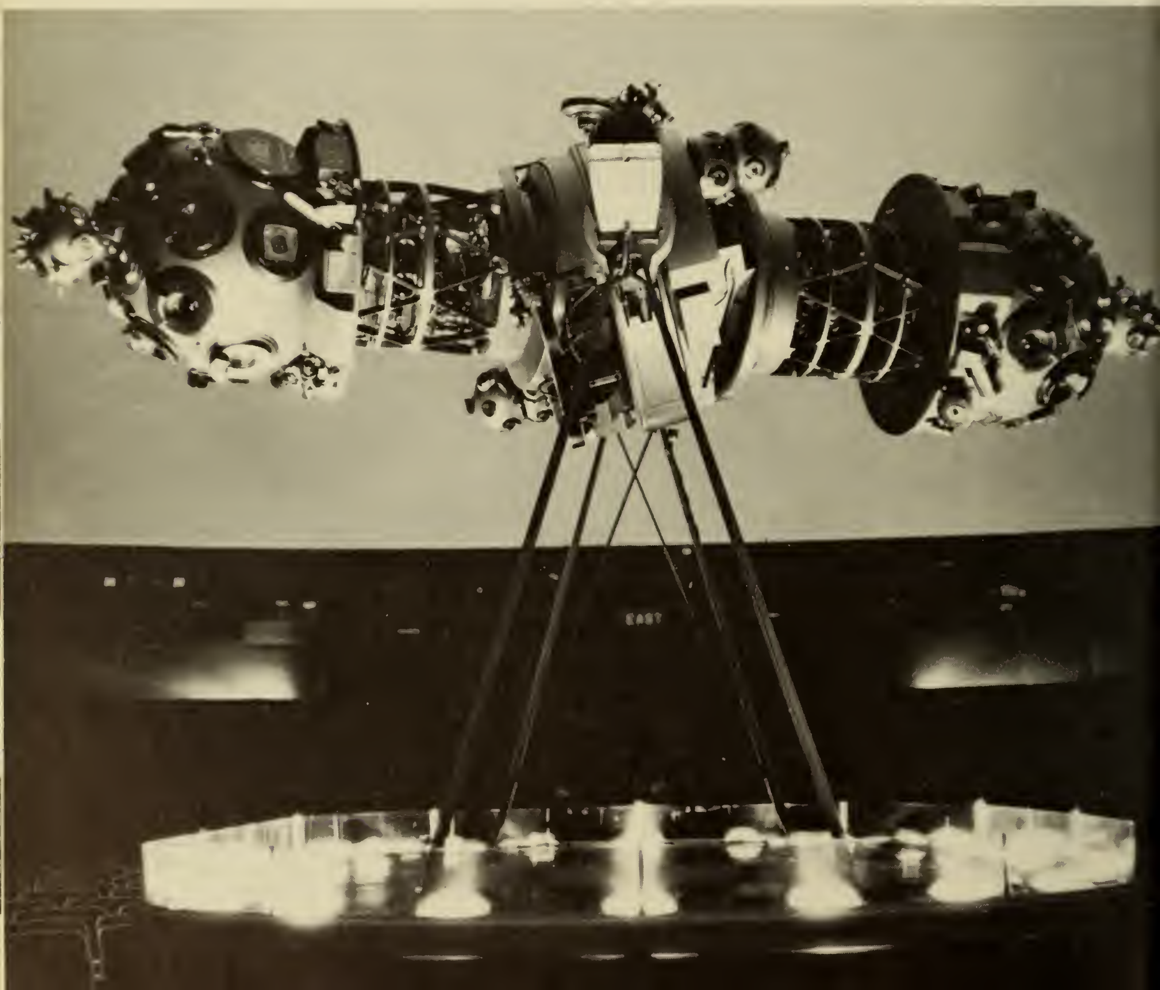
The habitat group is now nearly finished. Final lighting adjustments are made and the window inserted in the diorama frame. The work may have taken a year to complete and have involved twenty or thirty people. Yet this is only one item of the vast range of display work called for in the Museum. If, as has been said, the ideal museum should present the entire story of the universe in logical order, the skills of the exhibition department ought, indeed, to be limitless.

Astronomy

ASTRONOMY

The American Museum–Hayden Planetarium, adjoining the Roosevelt Memorial, with its main entrance on 81st Street and Central Park West (First Floor, Section 18), constitutes the Museum's Department of Astronomy. The establishment of the Planetarium in 1935 marked the culmination of a ten-year effort to secure a planetarium projector for The American Museum of Natural History. In 1933 the trustees of the Museum had formed a separate corporation under the Reconstruction Finance Corporation to build and equip a planetarium. Charles Hayden, after whom the building is named, donated the Copernican model solar system on the first floor and the original Zeiss planetarium projector. In 1960 the Charles Hayden Foundation also donated the Zeiss Model IV projector that replaced the original instrument. In 1969 the Zeiss Model VI projector was installed, again with the generous assistance of the Foundation. All of these projectors were developed by the firm of Carl Zeiss, now located in Oberkochen, West Germany.

Zeiss projector, with sixteen separate lens systems in each star globe.



The great Zeiss projector is the very heart of the Planetarium. It is installed in a hemispherical dome seventy-five feet in diameter and forty-eight feet from the floor to the highest point. The moving portion of the instrument itself weighs two tons and is twelve feet long. At either end of it are large star globes, each of which contains sixteen separate lens systems. In these lens systems are incorporated copper foil plates with holes of various sizes for stars of different magnitudes, so that a central light source causes the star images to appear on the dome with their relative intensities. The brightest stars are produced by separate projectors. The star images fit together so the constellations are reproduced exactly as seen in the real sky under ideal weather conditions. All the stars, some 8900 visible to the unaided eye from any part of the earth, are shown. Each of the thirty-two star field projectors is provided with a device that acts like an eyelid and automatically eclipses the star images when they reach the horizon. Individual projectors for the sun, moon, and the five planets that can be seen without a telescope are mounted in the latticed cylinder that supports these globes.

Above each of the two large star globes are smaller globes that throw upon the dome the traditional constellation figures used by early astronomers, matching them to the stars. The instrument also contains special projectors for showing the Milky Way, important variable stars, and the reference circles used by astronomers in describing the positions and motions of the celestial bodies.

The main projector turns independently on any one of three axes. First, it may turn on an axis parallel with the polar axis of the earth. This reproduces the apparent westward motion of the heavenly bodies due to the earth's rotation.

Second, it may rotate on an axis perpendicular to the plane of the earth's orbit about the sun. The effect of this is to swing the north pole of the heavens in a vast circle that is completed every 25,800 years. This motion, known to astronomers as precession, introduces a slow change over a long period of time in the sky picture. By its use, the instrument can be set back some 5000 years to 3000 BC, when Thuban, a dim star in the constellation of the Dragon, was our North Star. When the instrument is set ahead some 12,000 years, Vega, the fourth brightest star, marks the north pole of the heavens while the Southern Cross is visible from the latitude of New York.

The motions of the sun, moon, and planets are accomplished by a complex arrangement of motors and gears. They may be set in any position relative to the stars for any date and hour, and their motions reproduce precisely the motions of the actual planets. This so-called annual motion also sets the moon at its proper position and phase for any given time.

The dome itself, upon which the stars are seen, is made of perforated stainless steel, painted white on the inside, enclosed in an outer shell of concrete

Andromeda galaxy, as depicted in a mural in the Planetarium.

Instruments and drawings from the beginning of the fifteenth century, shown in "Astronomia."

and copper.

The Planetarium projector alone does not bring the entire sky story to the audience. Supplementary effects and techniques are constantly developed to widen the range of action. Horizon scenes, an observatory interior, a rainbow, a swirling blizzard, eclipses, the radiance of the Northern Lights, thunderstorms, and a host of accessory effects are created. These are combined with controlled lighting, music, and special sound effects into such performances as "Trip to the Moon," "From Galileo to Palomar," "Exploring the Milky Way," "Color in the Sky," "Messengers from Space," and the Christmas show, "The Star of Bethlehem." There is a change of program six times a year, and regular presentations are given at scheduled times throughout the year.

The Guggenheim Space Theater on the first floor incorporates Astrovision—Sight and Sound in the Round—comprised of twenty-two screens and forty-two projectors. Some 3000 slides, together with narrations by outstanding personalities, tell the stories of the earth, the moon, the solar system, rocketry, and telescopes. Suspended from the ceiling of the circular room is a forty-eight-foot model of the solar system in which the planets out to Saturn are shown moving about the sun at their proper relative speeds.

Pictures flash around the walls in an audio-visual introduction to astronomy in the Guggenheim Space Theater.

The Planetarium houses two of the world's finest meteorites: the Ahnighito, thirty-four tons, and the Willamette, fifteen-and-one-half tons. In addition to these, the Woman, a smaller meteorite of three tons, stands before the Planetarium Shop.

In the first floor corridor is an outstanding collection of sundials, compasses, and astronomical instruments, ranging from ancient Chinese, through the elaborate metal instruments made in the middle centuries in France and Germany, to the very accurate compasses of modern navigation.

Set into the walls of the corridors of both floors are large transparencies on glass of astronomical photographs from various observatories throughout the world. They include pictures of the sun and moon, many of the planets, star fields and star clusters, gaseous, planetary, and spiral nebulae, comets, meteors and meteor craters, as well as some of the most famous astronomical instruments. Since many of these photographs are time-exposures, they reveal the celestial objects far better than they could be seen visually through the largest telescopes—they show much detail that would otherwise escape the eye.

A striking exhibit of astronomical phenomena, painted in luminescent color activated by black light, is in the corridor on the first floor. Here are several murals, covering an area of 3000 square feet, showing in vivid detail such subjects as the surface of the moon, sunspot activity, the Aurora Borealis, eclipses of the sun and moon, galactic and spiral nebulae, and our neighboring worlds—the other planets.

Typical of the three-dimensional effect created by this recently developed technique is the mural of the Aurora Borealis. A curtain type of aurora is seen from the Arctic Circle where, due to the effect of black light, the aurora in the mural seems to shimmer, as do the actual Northern Lights.

Semipermanent exhibits are on the second floor of the Planetarium. "Your Weight on Other Worlds" is a set of five Toledo scales calibrated to show the effect of the gravitational fields of the Moon, Mars, the Sun, Venus, and Jupiter on the mass of the visitors' bodies in comparison to their weights on earth.

"Astronomia" is a hall that treats astronomy through the past 500 years. Many ancient books and instruments are displayed. Some of these belong to the Planetarium; others are on loan from the Adler Planetarium in Chicago, the Smithsonian Institution in Washington, and Harvard University. The display incorporates presentations of aspects of astronomy in varying typographs; some sections are very sophisticated, others are childlike in simplicity. One dynamic model shows the motions of a planet in a gravitational field. A Kinetoscope—a matrix theater of nine projectors—discusses the sun, moon, and stars.

Near the south entrance of the Planetarium dome is the Willetts Memorial Weather Hall. This display features a set of dials on which may be read outside

Willamette meteorite, weighing fifteen and a half tons, was discovered in Oregon and brought to the Museum in 1906.

temperature, barometric pressure, and wind direction and speed. These readings are automatically registered on the dials by remote signals from a weather tower high on the roof of the Museum. Flanking this weather information center are eight dioramas that graphically illustrate and explain phases of weather in the earth's atmosphere.

The combination of Planetarium projector and dome is ideal for instructional purposes—it is utilized in courses for laymen given throughout the year. Courses in astronomy, navigation, and aviation ground training are offered to the public, with sessions held once a week during the evening hours. Special school-group showings provide supplementary background for studies in astronomy. Other instructed groups include West Point cadets, U.S. Power Squadron units, engineering classes from neighboring universities, Scouts, and a variety of others. The Planetarium is available for special lectures at hours when there are no regular performances.

In the basement of the Planetarium there are comfortable classrooms for instruction of such groups. Near these is the workshop of the Optical Division of the Amateur Astronomical Association, which supervises and assists such activities as the grinding, polishing, and figuring of mirrors for reflecting telescopes.

Planetarium staff members are frequently called upon for explanations and advice about various astronomical, navigational, and meteorological problems. Parties of staff astronomers have traveled to locations favorable for photographing and studying recent solar eclipses. With the recent heightened public interest in sky phenomena, the Planetarium serves as a clearinghouse for information to the public directly by mail and telephone and by means of the press, radio, and television.

Thus, by well-integrated programs and active participation in school and community functions, The American Museum–Hayden Planetarium carries out its major purpose—that of helping the public to interpret for itself the vast body of scientific knowledge about astronomy and the allied sciences in terms of its own need and desire to understand the universe.

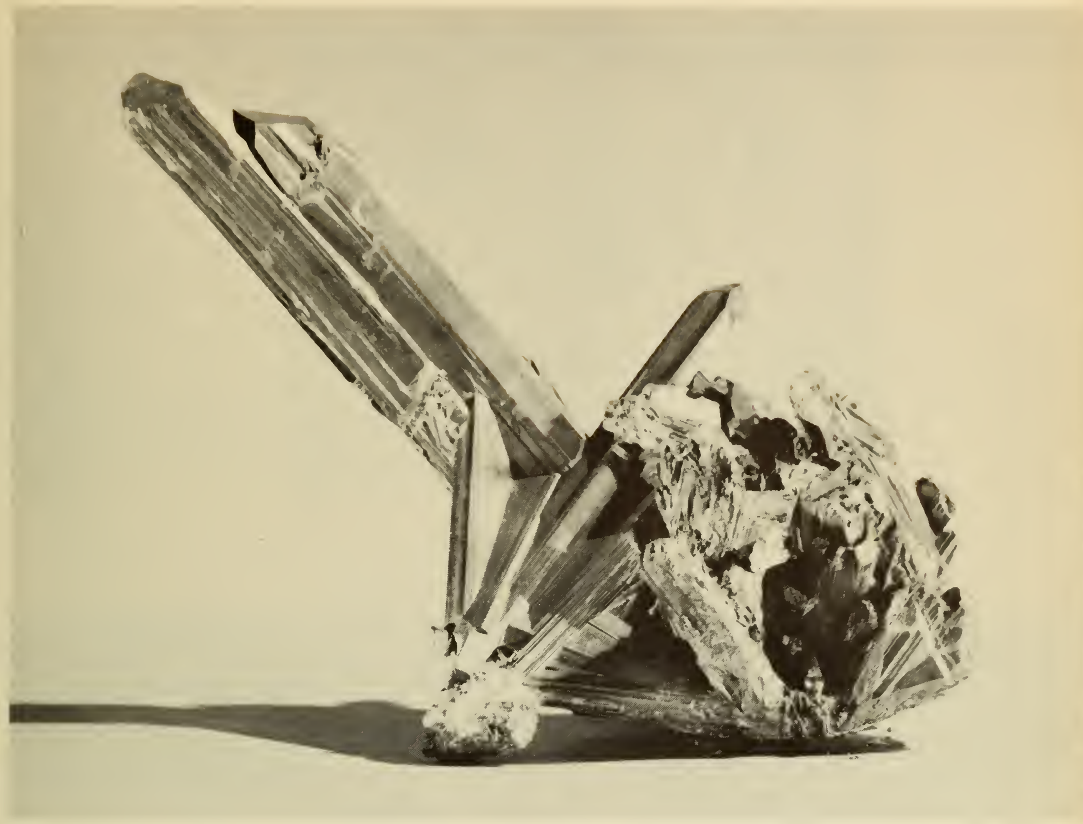
Mineralogy

MINERALOGY

Minerals are the materials of the earth—the forms in which nature distributes its chemicals. The familiar rocks of the earth's crust—the granite, marble, sandstone, and slate—together with other less well-known rocks form the mountains, canyons, continents, and ocean floors. Close examination of all these rocks reveals them to be natural aggregates of individual minerals. Each mineral has a characteristic chemistry and a fixed arrangement of its individual atoms. This provides for the distinctive properties of crystal form, hardness, density, color, luster, etc.

The identification of minerals, the understanding of their nature and occurrence, and the investigation of their properties are the primary activities of mineralogists. Pursuit of these activities using the methods of chemistry, physics, and mathematics and applying them in the field and in the laboratory provides the mineralogist with insight into the workings of nature and with knowledge of the components of the earth's crust. The science of mineralogy is therefore an integrated field of study related to geology on one hand and to physics and chemistry on the other. The different aspects of mineralogy have been systematized into the following outline:

Kunzite, the clear lilac-to-pink variety of spodumene, is occasionally found as flawless stones of 100 carats.



Japanese specimen of stibnite, which is the chief source of antimony and occurs in unique swordlike crystals.

Crystallography Concerned with the internal arrangement of atoms and the external geometric forms exhibited by minerals.

Physical Mineralogy Considers various physical properties, such as hardness, cleavage, color, specific gravity, magnetism, electricity, and tenacity, as well as optical properties.

Chemical Mineralogy Considers various chemical properties and the origin and formation of minerals. This includes chemical analysis, spectrographic techniques, x-ray fluorescence, and thermal analysis.

Descriptive Mineralogy Systematic listing of the various crystallographic, physical, and chemical properties of minerals and something of the environments in which they are found.

Determinative Mineralogy Classification of minerals based on physical properties and chemical composition that facilitates identification.

The Department of Mineralogy at the Museum is involved in various areas of research. Among them are studies of the chemical variations in igneous rock, studies of the inclusions in diamonds, attempts to determine the origins of stony meteorites, and the preparation of a description of rock-forming minerals.

When a professional mineralogist studies a new mineral deposit, he must first have an understanding of the geologic setting in which the minerals are found, and he gains this by examining and mapping the rock formations in the field. This gives information as to the origin of the deposit. Next, each material is identified in the laboratory. Some minerals may be determined by inspection, whereas others yield their identity only through chemical tests, through measurement of optical constants by microscopic means, or in other ways. The mineralogist may make x-ray diffraction of the minerals, since a crystalline substance will give a regular pattern recorded on photographic film when subjected to x-rays. The intensity and position of these lines are characteristic for each crystalline substance.

Mineralogist examines a specimen of rhodochrosite under the microscope.

Four precious sapphires. Two are brilliants, one is emerald-cut, and one is a star sapphire.

The mineralogist may borrow tools from the chemist and physicist, such as differential thermal analysis, where he subjects the mineral to a gradual rise in temperature and observes the characteristic chemical changes that take place. Or he may use spectrographic measurements to detect minor elements that might be unnoticed by the usual qualitative procedures. After all of the minerals of a deposit have been identified, the sequence of deposition can be worked out. Once this is known the mineralogist can speculate as to the origin of the minerals and the nature of the conditions that gave rise to them.

Mineral substances and products are indispensable to the welfare, health, and standard of living of modern man; they are among the most valued and jealously guarded of the natural resources of a nation. The outstanding characteristic of the present industrial era is the wide application of machinery and the use of power; animal muscle has been substituted by power machinery, including the steam engine, dynamo, automobile, airplane, and telephone. These inventions have brought about the use of minerals in an ever-increasing quantity and ever-widening application. As industrial techniques become more complex, minerals that contain metals with peculiarly distinctive properties such as aluminum, vanadium, tungsten, molybdenum, chromium, cobalt, and nickel have assumed real economic importance. For example, platinum, in addition to its use in jewelry, is a necessary catalyst in making sulfuric acid; it also acts as a key that unlocks a cheap process of chemical synthesis. Antimony is essential for the production of clear metal for type, and mercury is important in precise scientific instruments. All of the common materials used in modern building, such as steel, cement, brick, glass, and plaster, have their origins in minerals. The world constantly demands more food, and as a result the phosphates, potash, and nitrates are needed as fertilizers.

Morgan Memorial Hall of Minerals and Gems (Fourth Floor, Section 4)

The Morgan Memorial Hall of Minerals and Gems houses one of the outstanding collections in the world, a unique assemblage representative of nearly five billion years of earth history gathered from all over the world.

The hall is generally arranged according to the classification of minerals, beginning with the native elements. Many of the minerals form regular solids with smooth surfaces characteristic of each mineral species. These naturally occurring, regular forms are called crystals and are the external result of the unhampered growth and arrangement of the constituent atoms.

Certain minerals among the many hundreds of different species are of particular value; they are called gems because they appeal to a sense of beauty. The qualifications that make minerals gems include beauty of color, a certain degree of transparency that permits color qualities to be developed by cutting and polishing, and sufficient hardness to preserve them against wear. In addition, the value of gems is governed by their rarity and fluctuating fashions.

The Morgan Collection contains several outstanding gems, including the De Long star ruby and the "Star of India," the largest star sapphire in the world. There are also notable diamond crystals and glass models of the world's famous diamonds, both in the natural state and after cutting. Several fine specimens of chrysoberyl are in the collection. This aluminate of beryllium occasionally contains hairlike inclusions arranged in parallel bundles; when cut and polished it is known as "oriental cat's eye." The specimen from Kandy, Ceylon, is thought to be one of the world's finest.

Other Exhibits

Outside of the Hall of Mexico and Central America (Second Floor, Section 4) is a collection of gold objects and jewelry that shows the beautiful forms in which this element can be molded.

The John Lindsley Hall of Earth History (Fourth Floor, Section 2) shows how minerals were formed during the history of the earth.

Invertebrate Paleontology

INVERTEBRATE PALEONTOLOGY

As one of the earth sciences, invertebrate paleontology is concerned with all aspects of the lands, the oceans, the atmosphere, and the interior of the earth. The methods of physics, chemistry, astronomy, biology, and engineering are employed here in a combination embodied in geology, especially those aspects of geology devoted to determining the manner and sequence of events by which the planet and its life have evolved through nearly five billion years of geologic time. Using logical inferences about the past based on knowledge of present conditions, earth history proceeds step by step, tracing discernible evidence of changes through time.

Giant globe of the earth shows mountains both above and below the sea (Earth History, Fourth Floor, Section 2).

Typical Lower Triassic ammonite cephalopod. Ammonites are used by paleontologists to recognize fine divisions of geologic time.

The science of invertebrate paleontology explores the complicated patterns of evolution and environment that compose the billions of years of the history of life with special emphasis on invertebrate animals. More than ninety-five percent of all animals have always belonged to the invertebrate groups, and this overwhelming preponderance is directly reflected in the fossil record of the earth.

The Department of Invertebrate Paleontology at the Museum is involved in a number of research projects including studies of diversity, distribution, and evolution of the two largest fossil invertebrate groups—the arthropods and the mollusks. Current projects include the nature of evolutionary trends and the patterns of extinction and repopulation of these and other groups of animals during the earth crises that stemmed from climatic and other changes. The nature and history of tissue calcification in Mollusca and the history of the tropical zone of animals and plants are two other areas of research.

John Lindsley Hall of Earth History
(Fourth Floor, Section 2)

The John Lindsley Hall of Earth History was developed by the Department of Invertebrate Paleontology, in collaboration with other Museum departments, because many of the scientific concepts of invertebrate paleontology involve the interplay of physical and biological events in earth history.

A large rotating relief globe of the earth is the focal point of the hall. The globe is presented as an astronomical object in space. All of the planets and stars in the universe consist of certain chemical combinations. On the earth these ultimately form the rocks, minerals, and water that make up the surface of the planet. The globe shows the land surfaces, the seas (which cover nearly three-quarters of the earth's surface), and the newly charted mountains and plains of the oceans.

A film gives a synopsis of the history of the earth, from its very beginnings, through evolutionary changes, to the present. The film points out that within the earth itself is evidence of past history, known only from studies of earthquake waves and deep-seated materials brought to the surface in volcanoes, from outcropping rocks and their interrelationships, and from the fossil records of the evolutionary history of life preserved in the rocks.

The earth is dynamic and constantly changing. A cutaway section of a globe shows the interior of the earth, and there is a seismograph that records the shock waves of earthquakes. The different layers, or strata, of the earth are discussed in nearby exhibits. Eternal modification is illustrated in the different configurations of Fire Island, New York, where land masses, water, and climate have all changed throughout history. Alternating sea floods, folding of mountains, and volcanic eruptions have all contributed to the varied geologic makeup in metropolitan New York, producing both the igneous palisade rock of New Jersey and the schist of Manhattan visible in Central Park.

Within the soft sediments that were hardened into rock many invertebrate animals were buried. Their fossils were later exposed at the surface by uplift and erosion. The history of fossil evolution is found in their ever-deeper strata, and this organic evolution has provided paleontologists with a logical and scientific explanation of the changes in fossils through geologic time. Most fossil species belong to extinct creatures, and some of the animals and plants that lived during successive geologic time periods are shown in habitat groups of seafloor communities as they appeared when they were alive. Other displays illustrate the diversity, evolution, and structure of important fossil groups.

Dating of rock samples by measuring their radioactivity has proved the great antiquity of the earth, and studies of residual magnetism in combination with the chronology of fossils in the rocks provide the means for accurately compiling and correlating events in the geologic history of separate regions

Seismograph records shock waves as they pass through the earth (Earth History, Fourth Floor, Section 2).

Reconstruction of a Devonian coral community from upper New York State (Earth History, Fourth Floor, Section 2).

of the earth. These methods, which are discussed in the hall, aid in the analysis of stages in the origin of valuable products such as mineral deposits and petroleum and in predicting their locations.

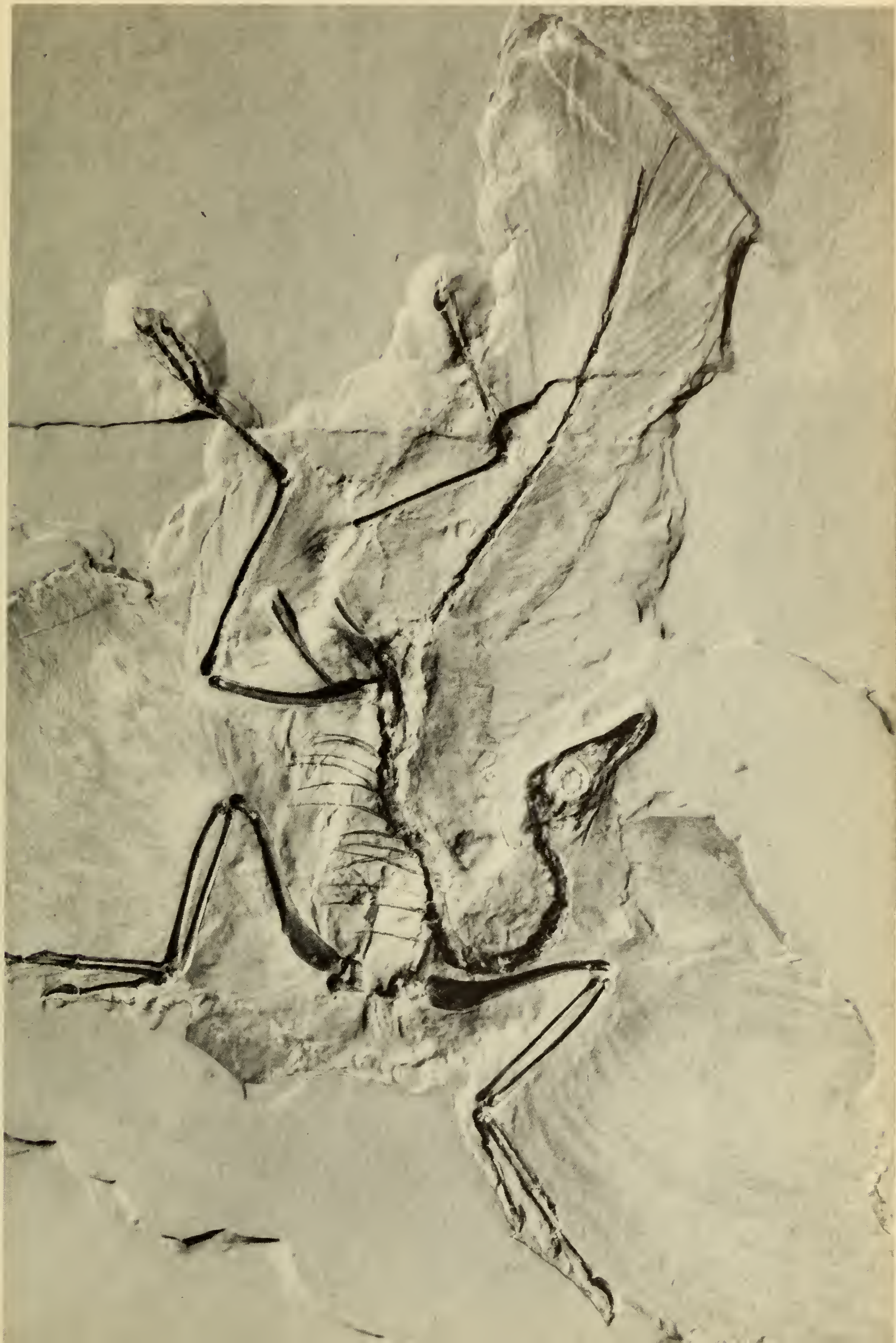
Dioramas of typical oil fields illustrate some of the factors involved in the location of oil pools, such as the geometric attitudes of the rock strata, geologic age, the depth beneath the surface, and the porosity of the rock.

Other Exhibits

The Hall of the Biology of Invertebrates (First Floor, Section 9) shows the modern forms of these animals. Vertebrate fossils, from fishes to mammals, are exhibited on the Fourth Floor. The ways in which fossils are collected, prepared, and studied are shown on the Fourth Floor, Section 4.

Model of a Pennsylvania coiled nautiloid cephalopod. This primitive relative of the squid is shown in its Texas habitat (Earth History, Fourth Floor, Section 2).

Vertebrate Paleontology



VERTEBRATE PALEONTOLOGY

Vertebrate paleontology is an interdisciplinary subject involving various aspects of biology and geology. It is concerned with the elucidation of the history and relationships of backboned animals through the interpretation of their fossil record. Fossil vertebrates first occur in rocks of Ordovician age, and they are known from sediments of all successive geologic periods. Since vertebrates became adapted to many different ways of life, their fossil remains are found in sediments deposited in a wide variety of environments.

One of the long-range research programs involving fossil fishes is aimed at working out the relationships of the various groups of higher bony ray-finned fishes through 400 million years. The Museum's fossil fish collection, which is one of the best of its kind, plays an important role in this research, and it is constantly being improved and expanded by Museum expeditions and by exchanges with other institutions.

Much of the emphasis in the study of fossil amphibians and reptiles has been on Mesozoic forms from various parts of the world. Research in this area has greatly expanded knowledge of the animals that lived during the Age of Dinosaurs, a critical interval in the evolution of the reptiles.

Studies on fossil mammals by Museum paleontologists emphasize the primitive mammals that lived during the early Tertiary and advanced mammals that inhabited North America during the last part of the Tertiary. The Museum's collection of fossil mammals, including the famous Frick Collection, is the largest in the world.

Fossil Fish Alcove (Fourth Floor, Section 13)

Fishes are free-living, aquatic, cold-blooded, gill-breathing vertebrates with fins. During their long history of nearly 500 million years many groups arose; they are shown on the adjoining family tree. The oldest known vertebrates were jawless fishes (agnathans) called ostracoderms. They appeared in the Ordovician Period and became extinct during the Devonian. The lampreys and hagfishes are the only living agnathans.

The first jawed fishes are represented by the acanthodians, spiny fishes that lived from the Silurian to the Permian. Although confined to the Devonian, the armored placoderm fishes (also jawed) existed in wide variety.

The sharks and ratfishes, which may be related to the placoderms, were already abundant in Devonian seas, but they declined in the Permian and Triassic. With the appearance of modern types in the Jurassic, sharks again became successful. The reconstructed plaster jaws and actual fossil teeth of a forty-foot Miocene shark are exhibited in the alcove entrance.

The higher bony fishes arose from acanthodian-like ancestors. They include the ray-finned fishes (such as herrings and sturgeons) and the lobe-finned fishes

CHARACTERISTIC FORMS OF LIFE

MAN

MAMMALS

DINOSAURS

PRIMITIVE REPTILES

AMPHIBIANS

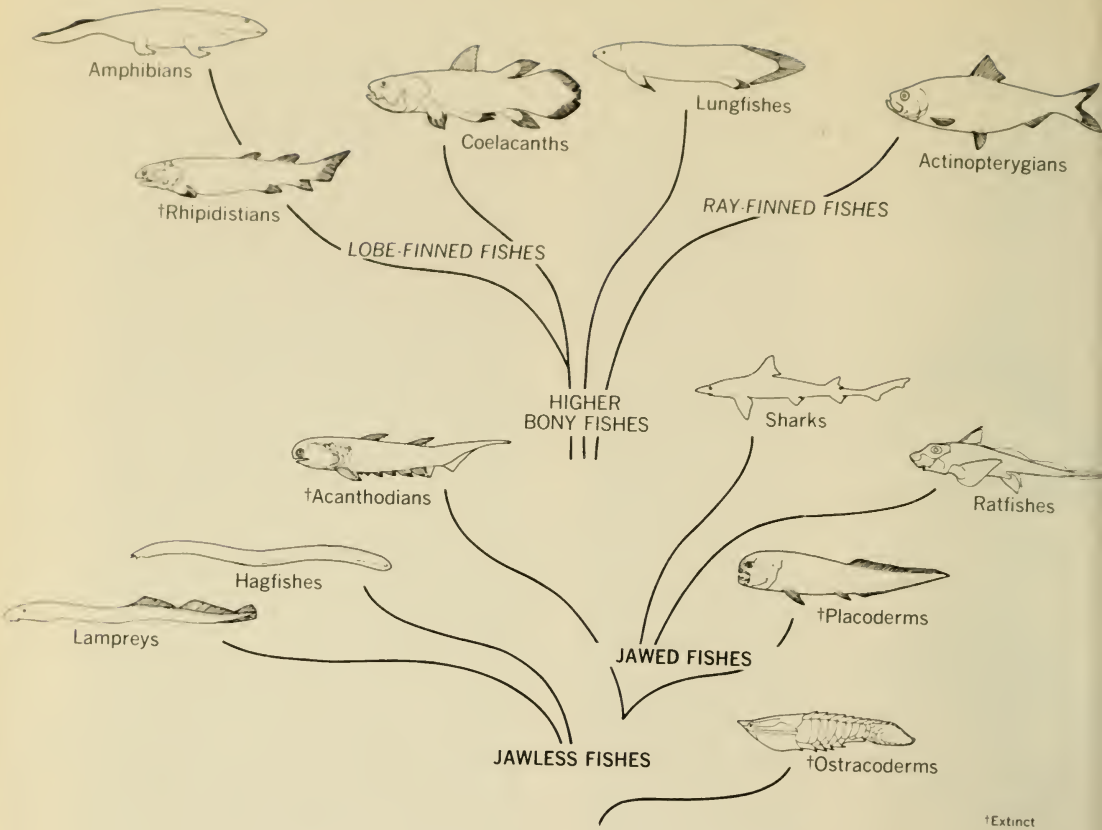
FISHES

INVERTEBRATES

BEGINNINGS OF LIFE

ERAS	DURATION OF PERIODS		PERIODS	MILLION YEARS AGO
CENOZOIC 62 MILLION YEARS DURATION		QUATERNARY	PLEISTOCENE	1.8
	62	TERTIARY	PLIOCENE	7
			MIOCENE	26
			OLIGOCENE	38
			EOCENE	54
			PALEOCENE	64
MESOZOIC 161 MILLION YEARS DURATION	72		CRETACEOUS	136
	57		JURASSIC	193
	32		TRIASSIC	225
PALEOZOIC 345 MILLION YEARS DURATION	55		PERMIAN	280
	65		CARBONIFEROUS	345
	50		DEVONIAN	395
	40		SILURIAN	435
	65		ORDOVICIAN	500
	70		CAMBRIAN	570
PRE CAMBRIAN			LATE PRECAMBRIAN	Ca. 2600
			EARLIEST KNOWN ROCKS	Ca. 3100

FORMATION OF EARTH: CA. 4600 MILLION YEARS AGO



Evolution of fishes. Branches that are now extinct are marked with a cross.

(such as coelacanths). From the Devonian to the present, the ray-finned forms (actinopterygians) have been the most numerous and diversified of all fishes. The lobe-finned fishes (sarcopterygians) are represented by the lungfishes and crossopterygians. They had a common origin with the ray-finned fishes. The conservative lungfishes have changed little since the Devonian; today they are represented by only three genera. The crossopterygians include the ancestors of the amphibians as well as the related coelacanths. A single species of coelacanth, *Latimeria chalumnae*, exists today in the Indian Ocean.

Other Exhibits

The Hall of Fishes and Ocean Life (First Floor, Section 10) shows modern fishes and traces some of their evolutionary history.

Early Dinosaur Hall (Fourth Floor, Section 13)

The Early Dinosaur Hall is dominated by the skeletons of three Upper Jurassic dinosaurs placed on a large center island. The largest of the three skeletons, that of *Brontosaurus*, is almost seventy feet long and eighteen feet high at the hips. In life it must have weighed thirty or forty tons. The aggressive, meat-eating *Allosaurus* probably preyed upon the big, inoffensive plant-eaters such as *Brontosaurus*, and in this group *Allosaurus* is mounted as if feeding on a brontosaur backbone. The third dinosaur in the group is the plated *Stegosaurus*, another plant-eater.

Original fossil brontosaur tracks were excavated near Glen Rose, Texas, and reassembled on the central island in the hall. There are six forefoot and six hindfoot impressions made by a brontosaur as it tramped through a limy mud millions of years ago. The three-toed tracks of an allosaur follow those of the brontosaur, and since two of the allosaur tracks are superimposed on two of the large brontosaur tracks, it is evident that the meat-eating dinosaur was actually following the big plant-eater.

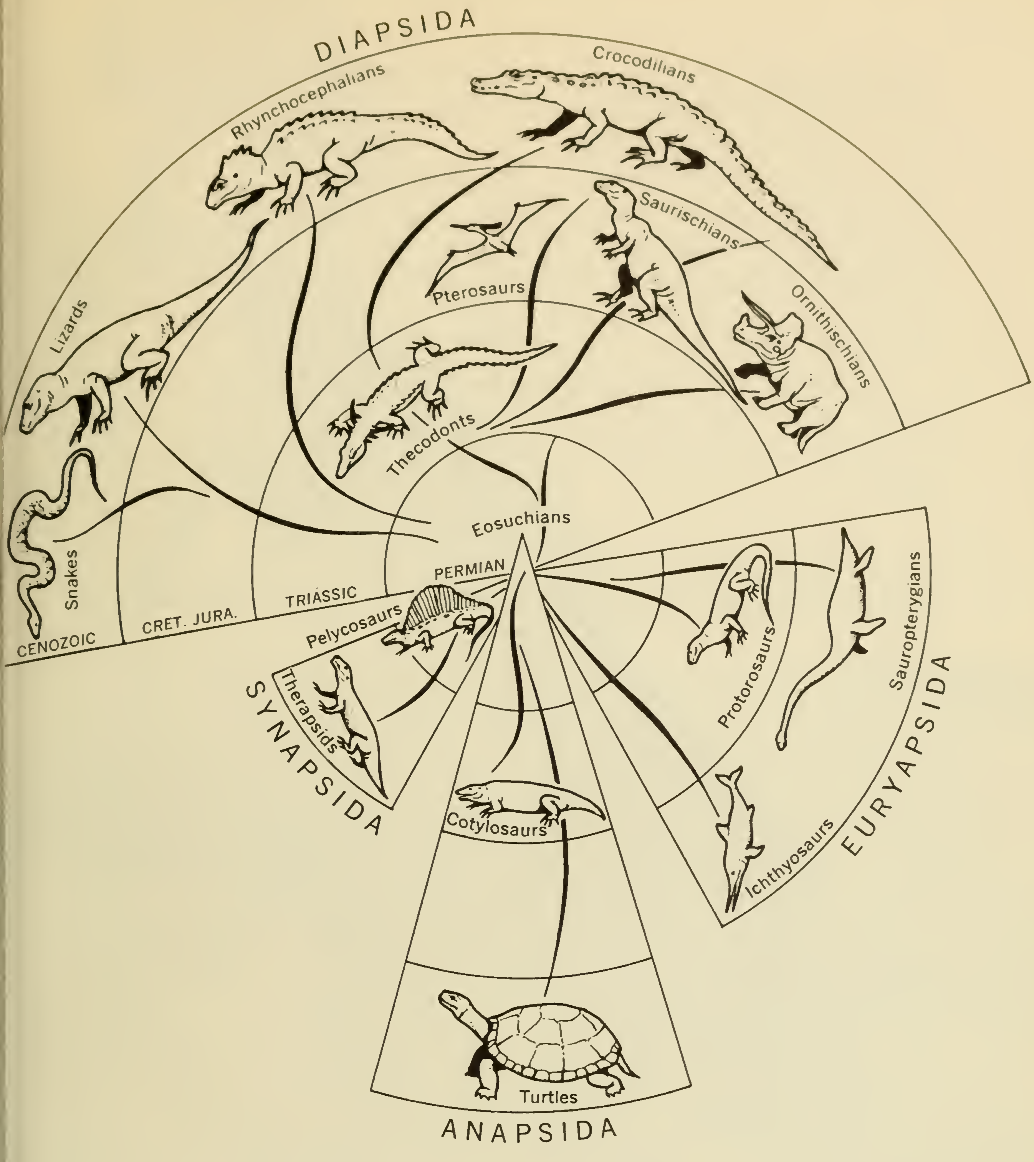
The first land-living vertebrates were amphibians, which arose from the lobe-finned fishes and developed along several evolutionary lines. They reached

Allosaurus, *Brontosaurus*, and *Stegosaurus* (left to right) as they might have looked millions of years ago (Early Dinosaurs, Fourth Floor, Section 13).

the culmination of their evolutionary development in the labyrinthodonts of the Permian, represented here by skulls and a skeleton of *Eryops*, and for a brief time they were in active competition with the reptiles for dominance on the land. The last labyrinthodonts lived in the Triassic, and they are exemplified by the large flattened form, *Buettneria*. Contemporaneous with the labyrinthodonts were various other amphibians, such as the bizarre genus *Diplocaulus*, a flattened form with an excessively broad skull, shaped rather like an arrowhead. The modern frogs and toads have a poor fossil record, and their closest relatives among the Paleozoic amphibians are not known.

The transition from amphibians to reptiles was so gradual that it is difficult to draw a distinct line between these two classes of vertebrates. *Seymouria* is one of a number of tetrapods that lie near the amphibian–reptile boundary. Although certain features of the skull and vertebral column are used to differentiate the two groups, one of the more significant differences lies in the method of reproduction. Amphibians must deposit their eggs in a moist environment, while reptiles have a self-contained egg with food and moisture enclosed in a hard shell. Although a reptile egg (some are shown in the Late Dinosaur Hall) is known from the Permian, it is impossible to associate it with any particular fossil skeleton.

Eryops, an early labyrinthodont amphibian from the Permian sediments of Texas, probably ate fish as well as land invertebrates.



Evolution of reptiles from their first representatives.

Mammallike reptiles called pelycosaurs developed during the Permian. Close relatives of the pelycosaurs were therapsids, some of which were directly ancestral to mammals, while others developed in different directions.

During the Triassic the dominant land animals were reptiles other than dinosaurs, and mammals appeared during the Late Triassic. But the dinosaurs were probably the dominant terrestrial animals throughout the entire Mesozoic, and they certainly dominated during the Cretaceous.

Late (Cretaceous) Dinosaur Hall (Fourth Floor, Section 9)

The Late Dinosaur Hall is devoted mainly to dinosaurs that lived during the Cretaceous Period. Examples are shown in the hall of three dinosaurs that lived together toward the end of the Cretaceous: *Tyrannosaurus*, the largest carnivorous animal ever to live on the land, *Triceratops*, a horned dinosaur that lived on plants, and *Trachodon*, one of the duck-billed dinosaurs.

The skeleton of *Tyrannosaurus* is about forty-five feet long and, as mounted, stands nearly twenty feet high. The huge skull, armed with sharp teeth, is in a case on the floor where it can easily be seen; a plaster replica is on the skeleton.

Protoceratops hatching from their eggs. These models are largely imaginary—no one really knows what they looked like (Late Dinosaurs, Fourth Floor, Section 9).

Tyrannosaurus, the largest land-living carnivore, preyed on other dinosaurs (Late Dinosaurs, Fourth Floor, Section 9).

Trachodon is often called a duck-billed dinosaur because the front of the skull is flattened and expanded into a sort of bill. However, recent studies on the feeding mechanism suggest that this bill was not used for feeding on soft, aquatic vegetation, as is the bill of modern ducks, but was part of a highly efficient slicing mechanism. The mummified remains of one duck-billed specimen clearly show the soft parts and skin of this animal.

The horned dinosaurs, or ceratopsians, were plant-eaters well adapted for defending themselves in fighting. Although not related, they were similar to modern rhinoceroses. The skeleton of *Triceratops* shows the characteristic pose of a ceratopsian dinosaur, the huge head lowered to present the three long, sharp horns toward an adversary. Ceratopsian dinosaurs had a large frill on the back of the skull that served in part as a protection for the neck but more importantly as an area of attachment for the heavy jaw and neck muscles.

At one end of the hall is a display of the pterosaurs, or flying reptiles. They arose in the Jurassic, at about the same time the first birds were evolving, and for some time they shared the sky with the early birds. There were many forms of flying reptiles, some as small as sparrows and others, such as the giant *Pterandon* on the wall, with a wingspread of twenty feet or more. In these reptiles the fourth finger of the hand was elongated for a wing support, and the wing itself was formed by a large fold of skin. Well-preserved specimens with skin and wing imprints show that the pterodactyls were covered with fine hairlike fibers similar to the hair of mammals.

Of particular interest are the skeleton and eggs of *Protoceratops*, found in Outer Mongolia by a Museum expedition in 1923. The eggs were the first dinosaur eggs ever discovered. In some of them are fossilized embryos, confirming speculation about the method of reproduction among these reptiles.

Other Exhibits

The John Lindsley Hall of Earth History (Fourth Floor, Section 2) explores the succession of life through geologic time and illustrates the formation of fossils.

Hall of Early Mammals (Fourth Floor, Section 5)

The beginning of the Age of Mammals was characterized by a radical change in the kinds of vertebrate animals that inhabited the earth. The dinosaurs disappeared at the end of the Cretaceous. Although the mammals had already evolved from their reptilian ancestors by the Jurassic, their dominance began at the start of the Tertiary, the period when they flourished rapidly.

The first true mammals of the Age of Dinosaurs are known mostly from fragmentary skulls and teeth. Enlarged models of these are placed on a family tree to show how the early mammals were related to each other and to their

Skeleton (top) and restoration (bottom) of *Ectoconus*, a primitive hoofed mammal of the Paleocene.

modern descendants.

The marsupials are a well-defined group of mammals including the common opossum and the kangaroo. Their most distinctive characteristic is that the young are born at a very immature stage and migrate to a pouch on the belly of the female, where they are suckled and carried for some time after birth. Placental mammals evolved a more efficient system of nourishment of the young in the uterus; consequently, the young are born at a more advanced state of development. The placentals multiplied and diversified rapidly in the Paleocene and particularly in the Eocene.

The first hoofed mammals, or condylarths, appeared in the Late Cretaceous and were abundant in the Paleocene and Eocene. The long, low skull, short limbs, and long tail were primitive characteristics shared for the most part with the earliest carnivorous mammals. *Meniscotherium* was a small condylarth about the size of a cat. *Ectoconus*, with its relatively small skull and heavy limbs, had the dimensions of a large dog. *Phenacodus*, which approached the size of a tapir, represents the stock from which the odd-toed hoofed animals (such as horses) probably arose.

The edentates are an order of mostly South American mammals including the sloths, anteaters, and armadillos. The ground sloths became common early in edentate history, and *Hapalops* is a typical Oligocene–Miocene form. The armadillos were abundant and varied in South America by the Miocene.

The first carnivores appeared during the early part of the Age of Mammals, and their remains have been found in Tertiary deposits on all the continents

Skull and restoration of *Andrewsarchus*, a gigantic wolflike mammal from Mongolia (Early Mammals, Fourth Floor, Section 5).

except South America and Australia. In Pliocene and Pleistocene times they migrated to South America via Central America. The dingo was introduced to Australia by aboriginal man.

One group of placental mammals was the insectivores. Fossils of these small, ancient mammals are exceedingly rare and are of great value in evolutionary study. Modern insectivores include moles, shrews, and hedgehogs.

During the Paleocene and Eocene the early primates were numerous and divided into a number of separate evolutionary lines. Many of them then became extinct, but some persisted through the Age of Mammals to produce lemurs, monkeys, apes, and, of course, man.

Historical zoogeography includes the study of the factors that have influenced the distribution of animals, particularly land animals, in the geologic past. It considers such factors as migration, the geographic isolation of groups of animals, their radiation from a point of origin, their sequence of arrival on a particular continent, animal distribution, and the evolutionary effects of this distribution on the animals themselves. At the very beginning of the Age of Mammals, when North and South America were loosely connected, there were three different groups of mammals in South America: primitive marsupials, edentates, and one group of early hoofed mammals. Later South America became isolated until perhaps four million years ago, and during this long period the mammal population developed along diverse lines.

Hall of Late Mammals (Osborne Memorial) (Fourth Floor, Section 3)

The fossil record for a few groups of mammals is unusually complete, and it is possible to follow evolutionary changes in the skeleton throughout many millions of years. The Hall of Late Mammals is especially concerned with some of the better-known records in the history of the placental animals.

Various types of odd-toed ungulates, or perissodactyls, descended from the earliest hoofed mammals, or condylarths. The perissodactyls were separated into the horses, rhinoceroses, tapirs, and several now-extinct lines by the beginning of the Eocene.

The rhinoceros, which originated in North America, had a complicated fossil history, and several distinct lines evolved in both the New and Old World. The largest known land mammal, *Baluchitherium*, of the Miocene of Asia, is a rhinoceros. The large block of *Diceratherium* bones, which includes the skulls of twenty-one small, pair-horned rhinoceroses, gives some conception of the enormous number of these animals living in North America during the Miocene.

The history of horses has long been of interest to students of evolution. The changes that occurred between the early Eocene *Hyracotherium* (also called *Eohippus*) and the modern horse can be traced with great exactness because

Late Pliocene in Arizona. *Glyptotherium* (relatives of armadillos) are on the left, *Plesippus* on the right. In the background are camels and mastodons.

Woolly mammoths along the banks of the Somme River in France during the late Pleistocene.

Giant Pleistocene ground sloths from Argentina. *Glossotherium* (the two specimens on the left) and *Lestodon* (right) attained enormous size during their evolution in South America (Late Mammals, Fourth Floor, Section 3).

Stenomylus, small North American camels. Some are the positions in which they were found on a Museum expedition (Late Mammals, Fourth Floor, Section 3).

of the excellence of the fossil record. The reduction in the number of toes to the single functional toe of modern forms, along with the lengthening of the limbs, skull, and teeth and the increase in general body size, are well demonstrated. Most of the history of the horse is recorded in North America because the group originated there, although it later spread to the Old World.

The even-toed ungulates, or artiodactyls, probably evolved from the condylarths in North America, but at an early date they spread to the Old World. There they gave rise to important groups that led to pigs, peccaries, hippopotamuses, camels, deer, giraffes, antelopes, and cattle. Perhaps the most successful artiodactyls of the mid-Tertiary in North America were the oreodonts, superficially piglike ruminants that were very abundant in the Oligocene and Miocene. The early evolution of the camel also occurred in North America, and a group of *Stenomylus*, a small Miocene camel of North America, is shown in the hall. Camels did not migrate to South America or Asia until near the end of the Age of Mammals.

Among the most spectacular mammals were the Proboscidea, remains of which are widely distributed. Mastodons comprised one group of the Proboscidea. The skeleton of the American mastodon on exhibit is known as the "Warren Mastodon." Collected in 1845 from shell-marl beds near Newburgh, New York, it is one of the most perfectly preserved fossil mastodon skeletons ever found. After exhibition in New York and New England, it was purchased by John Collins Warren, a professor of anatomy at Harvard College. It was on exhibition at the Warren Museum in Boston until 1906, when J. Pierpont Morgan bought it and presented it to The American Museum. In 1907 the skeleton was taken apart, cleaned, and remounted as it stands today. The American mastodon was the most abundant Pleistocene proboscidean in the forested regions east of the Mississippi.

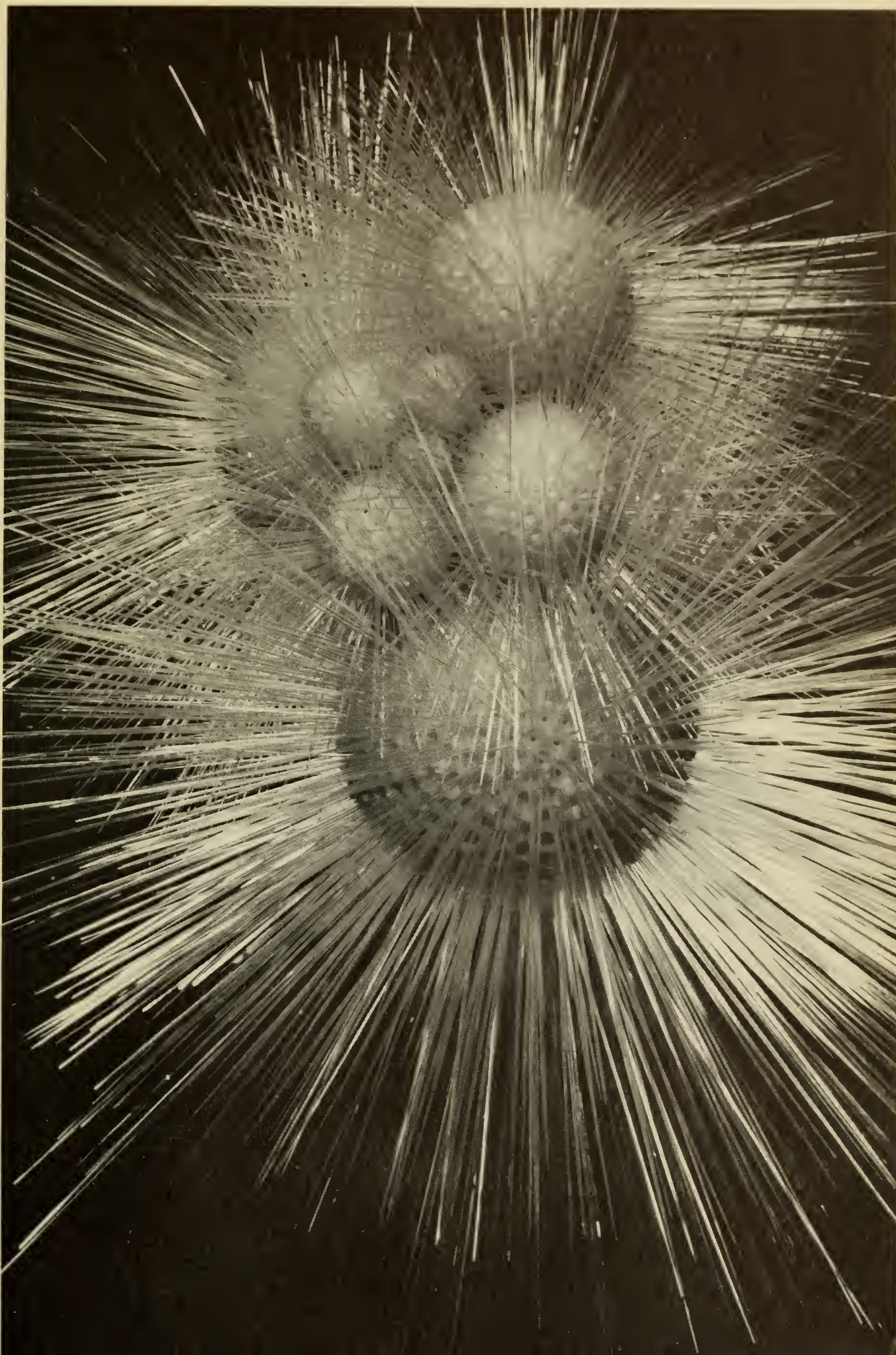
Mammoths belonged to another group of Proboscidea. The tall Colombian Pleistocene mammoth skeleton, with its great incurved tusks, is a dramatic example of a true elephant. Mammoth skulls and jaws are known from many parts of the world, and one of the largest known mammoth tusks, over sixteen feet in length, is exhibited here.

Fossils of many carnivores, such as cats, bears, wolves, and dogs, are shown. One exhibit shows how animals were trapped in the famous Rancho la Brea tar pits in Los Angeles.

Other Exhibits

Various halls of living mammals such as the Hall of North American Mammals (First Floor, Section 13) and the Hall of African Mammals (Second Floor, Section 13) show the end result of the evolution of these animals.

Living Invertebrates



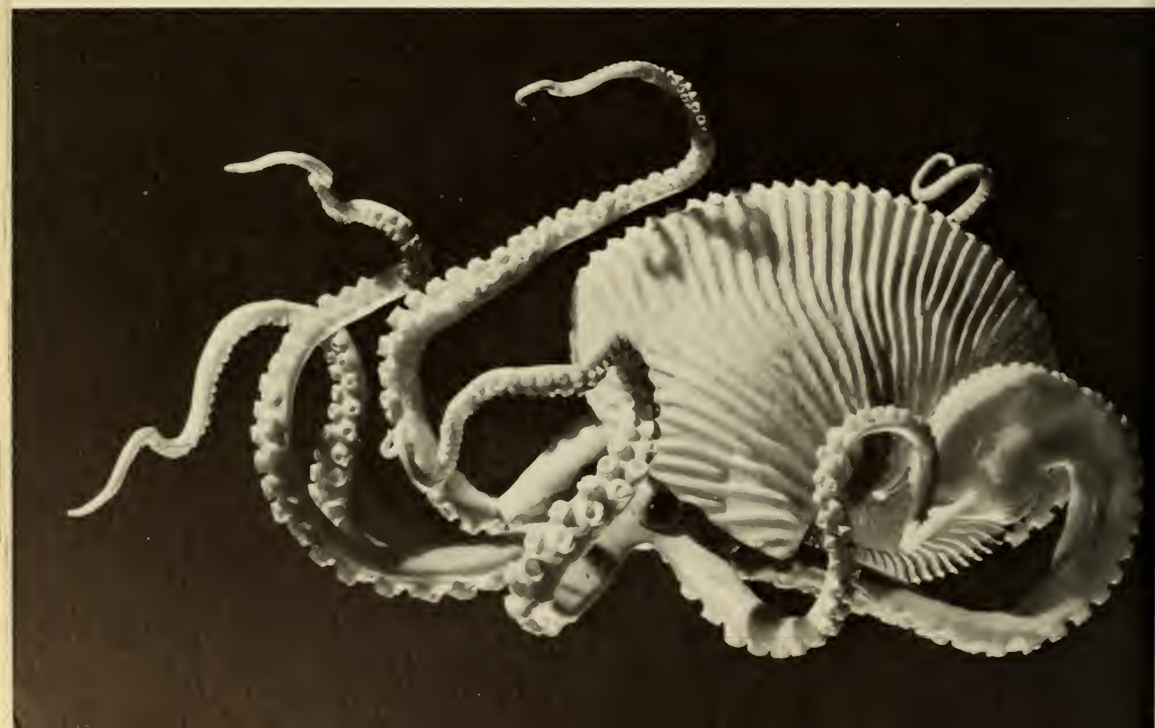
LIVING INVERTEBRATES

Invertebrates comprise approximately ninety-four percent of the known existing species in the animal kingdom. Responsibility for the care of the vast collections of living (as distinct from fossil) invertebrates in The American Museum of Natural History lies with two scientific departments: Entomology and Living Invertebrates. The Department of Entomology works with insects and their relatives, such as spiders, mites, and centipedes.

The remaining invertebrates are the concern of the Department of Living Invertebrates. They make up twenty-six of the twenty-seven phyla, the major groups into which all living animals are classified. The scientific collections of the Museum's department consist of such diverse organisms as minute one-celled animals (protozoans) and huge bivalve mollusks weighing 600 pounds (giant clams). Especially large holdings are the collections of mollusks (including snails, oysters, clams, and squids), with more than two million specimens; crustaceans (including shrimps, lobsters, and crabs), totaling nearly 120,000 specimens; and annelids and other worms, with about 40,000 specimens. There are important collections of other major groups of invertebrates.

In its laboratories and in the field, the Department of Living Invertebrates conducts varied research projects in evolutionary and experimental biology. These include the systematics and distribution of land, freshwater, and marine mollusks and of parasitic and free-living worms, and the hormonal control of color change, water balance, growth, and molting in land crabs.

Paper nautilus (*Argonauto argo* Linné). The structure that looks like a shell is a parchment-thin receptacle for this cephalopod's eggs.



Model of an American lobster (*Homarus americanus*) attacking a lady (or calico) crab (*Ovalipes ocellatus*) on the sound bottom (Biology of Invertebrates, First Floor, Section 9).

Hall of the Biology of Invertebrates (First Floor, Section 9)

The exhibits in the Hall of the Biology of Invertebrates provide a comprehensive view of invertebrates, their origin, classification, structure, physiology, development, behavior, adaptations to the environment, and economic, medical, and aesthetic importance to man.

As a joint undertaking of three scientific departments (Living Invertebrates, Entomology, and Animal Behavior), the hall reflects the differing approaches and philosophies of several intellectual disciplines. But intrinsic to all exhibits within the hall is a largely unstated commitment to three unifying biological concepts: the continuity of life, the diversity of life, and the inevitability of change. Exhibits in the hall are designed to impart the information discussed below.

Details of how life originated are still not precisely known, but it seems to have occurred in a series of steps, from gases to amino acids to proteinoids to microspheres, or precells. Models of DNA and RNA, essential to protein synthesis in cells, are shown, as is a three-dimensional model of a cell enlarged 40,000 times.

The incredible diversity of living organisms is the end result of continuity and change as one generation succeeds another through reproduction. To bring order to this diversity, scientific names and a place in one of the twenty-seven phyla have been given to over one million different species.

Organisms can reproduce asexually or sexually. In asexual reproduction, new individuals are formed from only one parent. Sexual reproduction involves two individuals of the same species and can occur in both single-celled and multicelled animals. It is advantageous because it results in new individuals with diverse genetic characteristics. But male and female sex cells, or gametes, must be brought together, which can be accomplished in a number of ways: by chance (in response to a chemical substance released into the water), by mass release of gametes, or by bringing a mature male and a mature female together at breeding time, with the male able to deposit its gametes in, on, or near the female.

Hereditary units called genes are in the chromosomes of cells. Generally, when a cell divides, the genetic material is apportioned equally between the two daughter cells (mitosis). But in the formation of the gametes, the number of chromosomes is reduced to one-half during cell division (meiosis). The original number of chromosomes is later restored when the male and female gametes unite to form a fertilized egg.

The fertilized egg of a multicellular animal divides and ultimately differentiates into many types of cells and tissues as different parts of the genetic material become active at different times. Active portions of the genetic material, by directing the synthesis of specific proteins, bring about the formation of various types of cells. Included in the genetic information of a fertilized egg are instructions for step-by-step development of the egg into an adult of that species and no other.

Change from one generation to the next is inevitable. In living organisms gradual change over long periods of time is known as evolution. Evolution results in organisms better suited, as a population, to their present habitats and areas and better able to invade new ones. It may occur either linearly, with a single population changing through time, or through diversification, during which the number of species increases. Both types of evolution usually proceed simultaneously.

Linear evolution, the kind that most people think of, is illustrated in an exhibit of oak beauty moths in New York City. Smoke and automobile exhaust fumes gradually darkened the trunks of trees on which the light-colored moths rested. As a result, they became conspicuous and were eaten by birds and other predators. Dark-colored moths, less vulnerable to predators, survived and reproduced; the population is now predominantly dark.

Just as there is an almost unbelievable diversity of form and function among species of invertebrates, so there is an equally remarkable diversity of behavior. Form, function, and behavior are interrelated, the latter directly or indirectly dependent upon the first two. As form and function gained in complexity during evolution, so also did behavior. For example, a paramecium has a low level

Model of a generalized cell, with all the components necessary for life (Biology of Invertebrates, First Floor, Section 9).

Two paramecia conjugating. They join to exchange genetic material and then separate.

of organization, but displays the greatest behavioral complexity possible for a single-celled organism; a sponge, which is multicellular, shows simple reflex behavior; a starfish still is unable to learn a simple sideward turn; and a clam worm can learn to move along a simple maze and learn a new turn when the maze is altered. But the octopus, the leading invertebrate in behavioral organization and resources, has a highly developed brain and can readily modify its behavior, learning quickly, for instance, to touch a white disk for meat and keep clear of a black disk, which gives an electric shock.

Glass model of a drop of pond water. The helmet-shaped objects are utricles (animal traps), the bladders of the carnivorous bladderwort plant (*Utricularia vulgaris*) (Biology of Invertebrates, First Floor, Section 9).

Model of a common octopus, an example of a cephalopod mollusk that has lost its shell through evolutionary development.

Modification of behavior is illustrated in the exhibit of how a flea circus operates. By using a conditioning technique, the trainer obtains fleas that respond to light by remaining quiet. By altering the lighting, he manages the selected fleas so that they appear to do "tricks."

Invertebrates show group behavior patterns, from quasi-social groups, such as associations of protozoans responding to chemicals from bacteria, to true social groups with complex social specialization and organization, such as some wasps, social bees, and ants. Some invertebrates show cyclic, or rhythmic, behavior. Plankton migrate in response to daily changes in the intensity of light; mussels feed rhythmically in response to tidal changes; bees go to buckwheat blossoms when they are open in the morning, but go to clover in the afternoon when the preferred buckwheat blossoms close.

An animal does not exist apart from its environment, and many diverse forms of invertebrates have evolved in keeping with their environments. For example, some are gigantic in comparison with their close relatives. The giant squid shown in the hall is an example.

Animals adjust to their environments in many ways. They receive stimuli from the environment and, in response, may find food, avoid predators, maintain body processes, and find a mate. Heat energy from the sun raises their body temperatures and thus speeds up their body processes; for example, crickets chirp faster at higher temperatures. But, in order to survive, a living animal must have more than light and heat. It must also have food, oxygen, and salts; it must obtain water and excrete wastes.

Invertebrates first evolved within the sea. As they encroached upon the land, they adapted to withstand the assaults of this hostile environment. Some found themselves already well equipped to invade a variety of freshwater and terrestrial environments. They became inhabitants of ponds, streams, and fields, and they moved into dark caves. They now live in very varied environments, from tropical rain forests to frigid Arctic conditions, from dry deserts to salt lakes.

Countless species of invertebrates are of economic, medical, or aesthetic importance to man—insects pollinate plants, earthworms cultivate soil, shells are used in artwork. Some invertebrates are parasites of man. Parasites are organisms that live in or on another larger organism, a host, and they depend upon the host for nutriment. Parasites may cause disease or discomfort, but they do not necessarily destroy their hosts. An example of a parasite is the body louse, which can live only on human hosts; it soon starves to death when removed.

The large majority of invertebrate pests are insects, and the most destructive of them are imported species that have left their natural enemies at home. Eradication of the pests is seldom possible; controlling them involves manipulating their environment and reducing their numbers so greatly that damage from them is not important. One pest is the cotton boll weevil, which infests cultivated cotton in the United States.

In the hall are the world-famous glass models of invertebrates created by the late Hermann O. Mueller of the Museum. There are protozoans, including the familiar freshwater amoeba and a variety of deep-sea radiolarians; rotifers, some of them enlarged versions of models in the exhibit of a drop of pond water, also a creation of Mueller; and coelenterates, including corals, sea anemones, hydroids, small jellyfishes, and large true jellyfishes such as the dangerous sea wasps.

Under enlarged models of flashing fireflies are seven displays showing the nature of bioluminescence, the natural light of several invertebrates. In a nearby alcove are exhibits of shrimps, lobsters, and crabs—familiar crustaceans.

Shells (First Floor, Section 2)

Of the 50,000 species of mollusks, most have shells ranging from a fraction of an inch to several inches in size. Some are microscopic, but others, such as the giant clam, attain a length of four feet.

The Evelyn Miles Keller Memorial Shell exhibit shows the classification of the major groups of living mollusks. The New York State Shell Exhibition identifies common mollusks of the region.

Other Exhibits

The John Lindsley Hall of Earth History (Fourth Floor, Section 2) shows the fossil past of invertebrates and the environments in which they evolved.

Many invertebrates are shown in the habitat groups in the Hall of Ocean Life (First Floor, Section 10), especially the Pearl Diver group and the Bahamian Coral Reef group.

Entomology

ENTOMOLOGY

Entomology is the study of insects, arachnids (spiders and their "cousins"), and myriapods (centipedes and millipedes)—the terrestrial representatives of the great phylum Arthropoda, consisting of segmented animals with external skeletons and jointed legs.

Systematics (also called taxonomy), or classification and nomenclature, is basic to all disciplines of biology, because no information about any organism is of scientific value unless the organism has been properly identified. Insects alone number some 850,000 species—eighty percent of all the known kinds of animals—and thousands of "new" ones are identified every year. The identification of an insect or spider is work for experts. Physiologists, behaviorists, ecologists, and other investigators must rely on taxonomists to name the species with which they are working. Since man himself is a land animal, in continual association with insects, dependent on them for much and competing with them for everything of organic origin that is useful to him, understanding of these animals is necessary for his comfort and prosperity, sometimes for his very survival.

South American tarantula and three examples of an ancient type of spider (*Hypochilus* sp.) from California.

One of many species of the praying mantis, a predator of insects.

The principal tool of systematists is a comprehensive collection of preserved specimens of known origin. The Museum's Department of Entomology houses one of the finest collections of terrestrial Arthropoda in the world. There are over fourteen million specimens, of which 36,000 are myriapods, 740,000 arachnids, and the rest insects. Accumulated through gift, purchase, exchange, and the fieldwork of Museum expeditions, the study collection continues to grow, and the task of maintaining it is formidable and endless. This collection is not on exhibition, but is stored in laboratories on the Fifth Floor, where it is available, by arrangement, to scholars and qualified students of all countries. Members of the department are concerned chiefly with research into systematics and evolution.

Exhibits

At present the Museum has no Hall of Insects and Spiders, but exhibits of insects can be found interspersed throughout those in the Museum. The origin and fossil history is treated in the John Lindsley Hall of Earth History (Fourth Floor, Section 2). The Hall of North American Forests (First Floor, Section 5) includes exhibits showing the importance of insects as pests and harvesters of trees, as links in the food chain of forest animals, and as components of the community of the forest floor. In the Warburg Memorial Hall (First Floor, Section 3) exhibits touch on insects as pollinators and pests of crops, as disposers of organic wastes, and as conditioners of the soil. Throughout the Museum, habitat groups often include a few of the most spectacular insects characteristic of the place represented.

The major exhibits concerning insects, however, are in the Hall of the Biology of Invertebrates (First Floor, Section 9). Here the Departments of Entomology, Living Invertebrates, and Animal Behavior worked to illustrate, in effect, animal biology with invertebrate examples.

Monarch butterfly on a milkweed flower, from which it will extract nectar.

Ichthyology

ICTHYOLOGY

Fishes have always been used by man for food, and today, as the world's human population is increasing, they represent an even more critical supply of vital, high-quality protein food. Fishes serve man in other ways, too—as sources of oils, vitamins, drugs, leather, animal food, fertilizer, and many other products. They are important in many forms of recreation—sport fishing, aquarium care, and skin and scuba diving. Laboratories use them for studies of animal behavior, physiology, genetics, and areas of medical research, such as the actions of drugs.

The Department of Ichthyology at the Museum carries out basic research in the classification, life history, and evolution of fishes. Scientists from all over the world study the nearly 500,000 specimens in the Museum's research collection, and students from nearby colleges and universities work toward advanced degrees using the resources of the department.

Scientist examines the skeleton of a filefish.

Cast of *Latimeria*, the coelacanth, a fish belonging to a group that was thought to be extinct but is today found in the Indian Ocean (Biology of Fishes, First Floor, Section 10).

Hall of the Biology of Fishes (First Floor, Section 10)

The exhibits on the mezzanine of the Hall of Ocean Life are designed to show the structure of fishes, how they meet the special demands of their aquatic environment, how they find food, how they avoid enemies, how they live together with other aquatic organisms, and how they reproduce. A large part of the hall is devoted to representative models of more than 400 families of fishes, showing their amazing diversity and how they are related. There is a section depicting the worldwide distribution of fishes, and in the arches around the hall are models of large and seldom-seen fishes from all parts of the world.

The term fish is generally used to describe backboned animals that swim by means of fins and breathe by means of gills. Actually, there are several varied groups of fishes that are more different from each other than mammals are from reptiles or birds are from amphibians. The first fishlike vertebrates are found in fossil rocks more than 500 million years old. These are agnathan fishes—they lack a lower jaw. Today the jawless fishes are represented by a few species of hagfishes and lampreys; the rest of the approximately 21,000 species all have jaws. About 400 species of sharks and rays have cartilaginous skeletons; the remainder are bony fishes.

The basic body plan of fishes is the same as other vertebrates. There is a central vertebral column with a complicated skull at the anterior, or head, end. The skull, which consists of many more bones than that of man, protects the brain and sense organs and supports the jaws and gill mechanism. There are two sets of paired fins, the pectoral and pelvic fins, corresponding to the four legs of mammals. In addition, most fishes have dorsal and ventral median fins as well as a tail fin. The fins and jaws are powered by muscles and supported by bone or cartilage. The internal organs and the circulatory, nervous, endocrine, digestive, excretory, and reproductive systems are specialized in various ways in different fishes but are not too different in structure and function from those of man. Four large models show the internal structures of fishes.

Because water is many times as dense as air, fish bodies are generally streamlined. Since fishes can move in three dimensions, they must be able to detect depth pressure and to adjust their buoyancy, usually by adding or removing gas from the gas bladder, a modified lung that is no longer used for respiration except in a few specialized fishes. Other peculiarities of the water environment—low oxygen content, reduced light transmission, extremes of water motion and pressure—are reflected in the fish structure.

Fishes live in a variety of habitats, from torrential mountain streams to the deepest parts of the ocean. A few species, such as the climbing perch, can leave the water for short periods, but all must remain moist. Because their eggs must remain wet at all times, fishes cannot reproduce on dry land. Each type of environment has special requirements that influence the form and physiology of the fishes. For example, fishes living in torrential streams, such as the hillstream loach, have special shapes and fin structures that enable them to remain in place without swimming constantly.

Many deep-sea fishes have light organs. One exhibit shows a school of luminescent lanternfishes reproduced from specimens collected by the deep submergence research vessel *Alvin*. Fishes that live in perpetual darkness in the depths of the ocean or in dark caves often have reduced eyes or have lost their sight entirely. Ordinary-appearing fishes may have physiological adaptations that permit them to tolerate extreme thermal and chemical conditions; for instance, several species living in habitats where little oxygen is available in the water can breathe atmospheric air.

In order to survive, every animal must first find the environment that is acceptable to it, and then it must have an adequate supply of food for energy, growth, and reproduction. Fishes feed on a wide variety of other organisms, and their food habits are reflected in their mouth structure and general body shape and color. The surgeonfishes eat mostly plants, although they may require animal matter as well. They have specialized teeth for cutting plants and gizzards for crushing the walls of the plant cells so digestive enzymes can reach the living material inside.

Parrotfish (top) bites off pieces of coral and turns it into fine silt. The queen triggerfish, here attacking a sea urchin, also has strong teeth with which it can chew coral (Biology of Fishes, First Floor, Section 10).

Carnivorous fishes have a bewildering array of specializations for locating, capturing, and digesting their prey. Some, like the gars, have teeth designed for grabbing and holding, while others, such as the bluefishes and barracudas, have slashing teeth for cutting chunks from large morsels. Still others have crushing teeth for smashing shelled animals. A number of fishes that feed on soft-bodied organisms have no teeth in the mouth, although nearly all fishes have pharyngeal teeth behind the gills. The elongate face of the African elephantfish enables it to feed on insect larvae in muddy bottom sediments.

By far the most common food item is other fish, and many predaceous species are little more than animated fishtraps. The goosefish in particular has an enormous mouth and a special long "fishing rod"—actually a modified section of the dorsal fin—with which it attracts prey.

Food and predation are two aspects of the same phenomenon; every species has its predators as well as its prey. Survival is dependent upon avoiding predators. Some fishes have armored skin or sharp, heavy fin spines that discourage predators; others avoid capture by camouflage and concealing or confusing colors and patterns. Many can alter their colors to match their backgrounds, and others have special means of changing their shape. Several fishes produce venoms that can be fatal to man, and some, such as the electric eel and torpedo ray, produce electric shocks that can stun a man. Other electrogenic fishes set up

Lophius piscatorius has a wormlike lure on its first dorsal spine that looks like food to a small flounder (Biology of Fishes, First Floor, Section 10).

a weak field that they use for navigating and locating prey in murky waters.

Mere survival of the individual does not ensure survival of the species, for all organisms grow old and eventually die. The only way new individuals can be formed is through sexual reproduction. Reproductive processes are varied in fishes, who must have ways of finding mates (sometimes involving long-range migration to spawning grounds) and courtship rituals to enable them to recognize the opposite sex of their own species. A number of fishes bear live young, which means they must have internal fertilization and special organs for transferring sperm from the male to the female; some carry the developing eggs in their mouths. Some fishes, such as the belted sandfish, are hermaphroditic—one individual produces both eggs and sperms.

Many fishes leave the fertilized eggs without further care, but others build nests and guard the young. The bitterling lays its eggs in the gill chambers of freshwater mussels; the splashing samlet deposits eggs above the water level and keeps them moist by splashing them with water every few minutes. One exhibit illustrates the life cycle of the Coho salmon, from its freshwater beginning, through its ocean life, to its death back in the stream where it was born. In each aspect of reproductive behavior, the objective is the same: to ensure that an adequate number of young survive to carry on the species.

No organism occurs everywhere in the world, and so each geographic

Mako shark, an excellent sport fish. Shark teeth grow in rows, one row replacing another as they wear out (Biology of Fishes, First Floor, Section 10).

Nassau grouper hides in a coral reef, the most complex environment in which fishes live (Ocean Life, First Floor, Section 10).

region contains a characteristic assemblage of fishes. The salmon of the northern coasts, the lungfish of the southern continents, the minnow, bass, and catfish—all have distributions that reflect the evolutionary history of the fishes superimposed on the history of the earth itself. Where a fish occurs depends upon how it is dispersed and whether conditions are suitable for it after its arrival—questions of opportunity and ecology. Land masses are barriers to ocean fishes; salty oceans block the dispersal of freshwater fishes. There are still many patterns of distribution that are not understood and are continually being studied.

The problems of finding a proper environment, obtaining food, avoiding predation, and reproducing are common to all living organisms. How the problems are solved depends upon the species. Through complex evolutionary processes, many different solutions have developed, and these are reflected in the more than 21,000 species of living fishes. The models of representative fishes in the hall give some insight into the diversity of variation on a common body plan that enables fishes to take advantage of every kind of aquatic habitat. Included are many rare, bizarre, and evolutionarily important fishes, such as the rays and skates and coelacanths. From giant sharks to tiny gobies, from slender needlefishes to stocky anglerfishes, from sleek mackerels to lopsided flounders—each species is uniquely in harmony with its environment.

Other Exhibits

On the lower floor of the Hall of Ocean Life (First Floor, Section 10) are habitat groups of marine animals of all sorts, showing how they live together and depend upon one another.

The Fossil Fish Alcove (Fourth Floor, Section 13) shows the evolutionary history of fishes from the earliest fossils.

Herpetology

HERPETOLOGY

The branch of biology that deals with the amphibians and reptiles is known as herpetology. In its broadest sense, herpetology is concerned with the origin, evolution, distribution, and classification of the amphibians and reptiles, their relationships to their environment, their life histories, their habits and behavior, and their structures and functions. Herpetology is also concerned with the economic importance of amphibians and reptiles and their bearing on the activities of man. The study of extinct amphibians and reptiles is usually included under paleontology.

The staff of the Department of Herpetology at the Museum conducts research along a variety of lines, all directed toward achieving a better understanding of the evolution and ecology of amphibians and reptiles. Attaining this goal involves the integration of studies on preserved specimens in the laboratory (the Museum has one of the world's largest and most comprehensive collections) with studies of living animals in the laboratory and field.

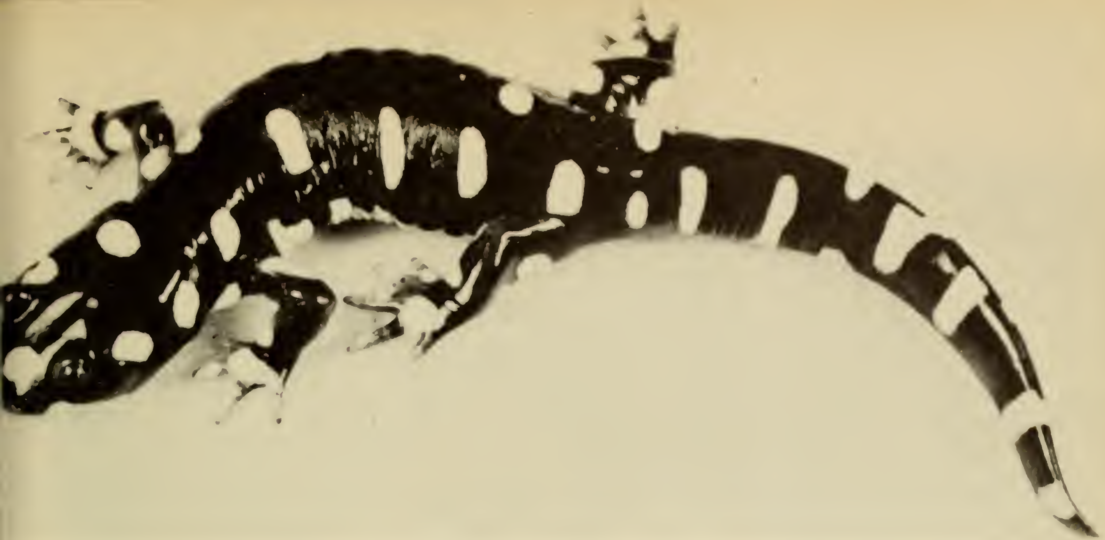
Gonyocephalus nigrigularis, from New Guinea, is one of the some 3000 forms of lizards existing today.

Young crocodile (*Crocodylus acutus*). Most species of crocodiles are endangered because man has hunted them for their hides.

Investigation of the anatomy of preserved specimens helps to determine the relationships among different species and thus casts light on their evolutionary histories. Such studies are also pertinent to the animal's ecological relationships because they promote an understanding of how its anatomical features relate to its way of life. Studies of living amphibians and reptiles in the field (often of animals marked so that they may be recognized when recaptured, perhaps years later) reveal such facets of an animal's life history as breeding habits, rate of growth, food habits, movements, and longevity. Conventional anatomic and life-history investigations are supplemented by diverse specialized studies. For example, electronic instruments are used to analyze the tape-recorded vocalizations of frogs; high-power microscopes enable comparisons of chromosomes among different species.

Amphibians are backboned animals with a moist glandular skin. They lack the protective covering of feathers or hair seen in the higher vertebrates; scales are rarely present and are then hidden in the skin. Amphibians lay their eggs in water or at least in moist places on land. Most young amphibians pass through a fishlike, water-dwelling stage, where gills are used for breathing, before metamorphosing, or changing, into the adult, air-breathing form. There are three major groups of living *Amphibia*: caecilians (*Gymnophiona*), superficially wormlike, limbless creatures, of burrowing as well as water-dwelling habits, that live in the tropics; salamanders (*Caudata*), or tailed amphibians, usually having four limbs, confined to the northern hemisphere, except for several South American species; frogs (*Salientia*), including those popularly called toads, tail-less amphibians with relatively long hindlegs and a hopping or leaping mode of progression. Frogs are found on all major land areas of the earth (except Antarctica and Greenland) but are absent from most oceanic islands. The three groups of amphibians comprise a total of approximately 2500 living species.

Hyla ebraccata is an inch-long tropical tree frog that sleeps during the day and hunts insects at night.



North American tiger salamander (*Ambystoma tigrinum*) is black with vivid yellow markings and spends most of its life underground.

Box turtle (*Terrapene carolina*) lays its eggs in holes in the ground of the forest where it lives.

Amphibians evolved from lobe-finned fish ancestors well over 300 million years ago. Some fifty million years later one amphibian stock gave rise to the reptiles. Thus the amphibians are classified between the fishes and the reptiles.

Reptiles are backboned animals with dry, scale-covered skins. Many species give birth to live young, but most lay eggs, always on land. When the reptile emerges from its egg it is similar to its parents and is equipped to breathe air. The major groups of reptiles include: turtles (*Testudinata*); alligators and crocodiles (*Crocodilia*); "beakheads" (*Rhynchocephalia*), represented by a single species, the relict tuatara (*Sphenodon punctatum*) of New Zealand; lizards and snakes (*Squamata*), considered units of a single group. The close evolutionary relationship of lizards and snakes is indicated by numerous similarities, including the existence of snakelike characteristics in several lizards and the retention of vestigial pelvic girdles in some snakes.

Approximately 6000 species of reptiles now exist; many others have passed into oblivion or are known only from their fossilized remains. The reptiles flourished at an early period of their evolution, well over 200 million years ago. The original stock gave rise to a variety of forms, including the dinosaurs. Other stocks led independently to the warm-blooded mammals and birds. Many stocks, including the larger "ruling reptiles," failed to survive. The modern reptiles include a few species of great size—some marine turtles may reach a ton in weight, and crocodiles twenty-four feet in length may weigh even more. The largest surviving lizard is scarcely ten feet long, but some snakes are thought to exceed thirty feet.

Exhibits

New exhibits depicting the biology of amphibians and reptiles are under construction, and at present there is no specific area in the Museum devoted to these animals. There are many amphibians and reptiles in habitat groups in other halls, however. For example, a sea turtle is shown with a shark in the Hall of Ocean Life (First Floor, Section 10). A frog sits on the edge of a pond in the Warburg Memorial Hall (First Floor, Section 3). A rattlesnake is in a cypress swamp in the Hall of North American Forests (First Floor, Section 5), and other snakes are shown in the mammal and bird halls.

The ancestors of the reptiles are shown in the Dinosaur Halls (Fourth Floor, Sections 9 and 13).

Ornithology

ORNITHOLOGY

The science of bird study in all its aspects is known as ornithology. A major task of the ornithologist is to describe and name the birds of the world and to arrange them into species, genera, families, and higher categories of kinship. About 8700 species are known. There is still much to learn concerning the evolutionary relationships of the families and orders of birds. New methods in systematics, as applied to populations of closely related birds, are constantly leading to a better understanding of the process of evolution.

Migration, homing, direction-finding—the whole range of a bird's behavior, to the extent that it is modifiable by learning—as well as its genetics and its adaptations, are today being intensively studied by critical experimental methods, both in the laboratory and in the field. Quantitative and statistical techniques have largely replaced random observation. Computers, electron microscopes, and other new tools are facilitating broader approaches to many problems.

As a result of their striking characteristics, living birds offer a very fruitful subject for research in animal behavior. Because of these advantages, and the numerous scientific advances made by ornithologists, many universities are adding trained ornithologists to their biological faculties.

The Museum has about one million bird specimens in its collection. With such a large collection, dating from many years ago to the present and aided by field and aviary studies, all aspects of bird biology and evolution can be studied. An important side result of such collecting has come from the study of the collection of eggshells. Those of a hundred years ago are thicker and stronger than those of today; the change is a result of the extensive use of DDT and other pesticides.

Domestic goose hatching from an egg (Biology of Birds, First Floor, Section 19).

European cuckoo lays its eggs in the nest of another bird. The young cuckoo pushes out the other nestlings. Here a garden warbler pushes food down the throat of the much larger young cuckoo (Biology of Birds, First Floor, Section 19).

The Whitney Wing (Section 19)

The Whitney Wing of the Museum was built in the 1930s as a joint gift of Harry Payne Whitney and the City of New York. It is wholly occupied by the Museum's Department of Ornithology. Two of the seven floors of the wing are devoted to public exhibits.

Sanford Hall of Bird Biology (First Floor, Section 19)

The Sanford Memorial Hall of Bird Biology is devoted to exhibits illustrating the structure, descent, classification, and behavior of birds and their relation to man. The exhibits deal with fundamental scientific problems. There are also examples of all the families of birds from penguins to finches.

A large exhibit of tropical water birds in flight against a sunset sky faces the entrance of the hall, and a number of other habitat exhibits show beautiful and spectacular birds, extinct species such as the dodo, and certain extraordinary aspects of reproductive behavior.

A number of remarkable fossil birds are exhibited. Among them is the toothed swimming bird, *Hesperornis*, which lived in the age of dinosaurs sixty million years ago. Some bones and an egg of *Aepyornis*, the so-called "elephant-bird," are shown. This bird was the heaviest known, weighing about 1000 pounds. With it is shown the skeleton of a hummingbird, the smallest bird in the world.

Other exhibits in the hall display aspects of bird life, such as evolution, distribution, and migration. One alcove depicts the cultural and economic value of birds to man.

Whitney Memorial Hall of Oceanic Birds (Second Floor, Section 19)
The displays in the Whitney Memorial Hall of Oceanic Birds represent the bird life of far-flung islands of the Pacific Ocean, from the Arctic nearly to the Antarctic and from the coast of Peru to the Great Barrier Reef of Australia. The painted backgrounds are all the work of one artist, the late Francis Lee Jaques.

The spectator has the illusion that he is in the middle of the Pacific Ocean viewing scenes in every direction for hundreds or even thousands of miles. From a common horizon linking the painted backgrounds of the habitat groups, the sky appears to rise above the exhibits to the blue dome forming the ceiling. Suspended from this sky are examples of oceanic birds in flight.

In the hall are many of the world's most remarkable birds—the rare honeycreeper of Hawaii, the extinct moa of New Zealand, the unique tooth-billed pigeon of Samoa. The habitat groups in which these birds are shown depict many of the romantic or historic islands of the Pacific—the Marquesas Islands where Melville's *Typee* was located, Corregidor and Guadalcanal of World War II fame, the Galápagos islands that were visited by Darwin in 1835.

Birds of New York City (Third Floor, Section 13)
Despite the great congestion of buildings in the New York metropolitan area, a large variety of birds is still to be seen there. The number of nesting species is dwindling, however, as more and more marshes and other favorable habitats fall before the spread of business and residential construction. This very restriction of habitat, though, leads to some remarkable concentrations of migratory birds. Central Park in particular has long been favored in this respect, and over 200 species of birds have been recorded in this oasis of greenery in mid-Manhattan.

The exhibit, located next to the Hall of North American Birds, includes most of the more than 300 species of birds that are known to occur with reasonable regularity in the New York area.

Roosevelt Sanctuary Group (First Floor, Section 12)
In the entrance hall of the Roosevelt Memorial Building on the first floor is a group showing many of the summer birds found in the Theodore Roosevelt Bird Sanctuary at Oyster Bay, Long Island, an area now administered by the National Audubon Society.

Hall of Birds of the World (Second Floor, Section 2)
Birds live in all parts of the world, from mountaintops to the high seas, as is apparent in the Hall of the Birds of the World. The habitat groups show a great variety of birds of all sizes, colors, and habits. Their attributes are the result of adaptation to all sorts of environments. The habitat groups show

Greater bird of paradise in Papua, New Guinea. Once killed by the thousands for their beautiful feathers, the birds are now protected (Oceanic Birds, Second Floor, Section 19).

Varied seabirds on a cliff on Little Diomede Island in Bering Sea. Murres, guillemots, puffins, auklets, gulls, and cormorants come here each summer to lay their eggs and rear their young (Oceanic Birds, Second Floor, Section 19).

Brandt's cormorant with its young at a nesting site near Monterey, California (North American Birds, Third Floor, Section 1).

Swainson's hawk, still quite young, practices flapping its wings until it is strong enough to fly and catch prey for itself (Biology of Birds, First Floor, Section 19).

Little blue heron standing at its nest in the Cuthbert Rookery of the Everglades National Park (North American Birds, Third Floor, Section 1).

such birds as king penguins on the frozen shores of South Georgia Island in the Antarctic, cranes assembled at a lake in the Gobi Desert (collected by Roy Chapman Andrews of dinosaur-egg fame), scintillating copper pheasants on the lower slopes of Fujiyama in Japan.

Birds are certainly among the most noticeable and attractive of living creatures. Like man, they are active by day and their sight and hearing are the most important of the five senses. Because of these traits they are easier to study than many other living things.

Chapman Hall of North American Birds (Third Floor, Section 1)

The Chapman Hall of North American Birds, on the third floor, was built in the early 1900s under the guidance of Frank M. Chapman. It was the first hall in any museum in the world devoted to the habitat type of group display. The hall was renovated during the 1960s, but many of the exhibits are essentially the same as when they were first installed.

The hall exhibits many of the species that comprise the rich bird life of North America. Large, dramatic, and endangered species are featured, although there are intimate displays of warblers and other smaller birds.

The hall contains the world's only habitat exhibit of the extinct labrador duck, of which fewer than fifty specimens exist in the collections of the world. Among the dwindling or endangered species included are the American, or bald, eagle, the peregrine falcon, the California condor, and the whooping crane.

Other Exhibits

Various other exhibits in the Museum contain birds. For example, the Nile River Group in the Akeley Hall of African Mammals (Second Floor, Section 13) contains a fine specimen of the rare and remarkable shoebill, or whale-headed, stork. In the balcony of the same hall is a group showing a family of ostriches, the young just hatching from huge eggs, the parents concerned with the approach of a group of wart hogs—enemies of the eggs and young. Nearby is a group depicting vultures and other scavengers at the carcass of a zebra.

Young ostrich just after hatching in the Ostrich-Wart Hog Group of the African Hall Gallery (Third Floor, Section 13).

Mammalogy

MAMMALOGY

A mammal is a warm-blooded, backboned animal with fur or hair. The young are fed with milk by the mother. Mice, cats, dogs, horses, elephants, whales, monkeys, and men are mammals. Birds, snakes, frogs, turtles, and fishes all have backbones but are not mammals—they have neither fur nor hair nor do they nurse their young with milk.

The Department of Mammalogy is devoted to the study of mammals—classification, development (including growth and size), distribution, adaptation to environment, abundance, and many other areas of research. Field and laboratory investigations are reported in both scientific and popular publications.

The department is also responsible for the accuracy of the mammals in exhibits in the various halls, where representative mammals from all parts of the world are shown in the environments in which they live. Natural habitat exhibits have a multiple purpose: the visitor sees the animal at home, he appreciates the relationship between the environment and the kind of creature that can live in it, and he should realize the necessity of preserving such environments if the animals themselves are not to be driven out of existence. Thus the aims of both education and conservation are served.

Musk oxen, with long, dense fur and hair, are especially adapted to live in cold climates (North American Mammals, First Floor, Section 13).

Minks, members of the weasel family, are ranch-raised for their valuable fur (Corridor of Small Mammals, First Floor, Section 13).

Hall of North American Mammals (First Floor, Section 13)

The varied environments and habitats of North America are shown in the displays of the larger mammals. The cold of the tundra, home of caribou and musk-ox, the craggy peaks where mountain goats and mountain sheep dwell, and the vast evergreen forests inhabited by moose exemplify some of the northern regions. Brown bears are shown in Alaska at a salmon stream, grizzlies at the edge of a canyon in Yellowstone National Park, and black bears in the cypress swamps of Florida. The vast herds of bison that once covered the western plains together with fleet pronghorn antelope are exhibited in the center of the hall.

The Grand Canyon of the Colorado River is the setting for the mountain lion group, while America's largest cats, jaguars, are shown at dusk in arid Sonora, Mexico. A much smaller cat, the lynx, is shown tracking a snowshoe hare in Canada.

Closer to home, white-tailed deer are exhibited in a setting near New York City, while the mule deer and the wapiti are displayed in typical western settings.

In the corridors on the sides of the hall other characteristic North American species—coyotes, beavers, skunks, squirrels, opossums, foxes, porcupines, raccoons, and jackrabbits—are shown in typical habitats.

At one end of the hall an illuminated map shows the migration routes taken in past ages by animals moving between Asia and North America. At the other end of the hall, two miniature dioramas show animal life of North America in ages past.

Indian leopard. Both Indian and African leopards eat large birds such as this peafowl and mammals such as wild pigs and gazelles (Asian Mammals, Second Floor, Section 9).

Corridor of Small North American Mammals (First Floor, Section 7)

Many of the smaller and uniquely American mammals are displayed in this corridor in small habitat settings. Some of the more valued fur-bearers—mink, wolverine, marten, and muskrat—are exhibited in settings from the Canadian tundra to the Louisiana marshes. The black-footed ferret, one of the rarest and most endangered of American mammals, is shown peering into the burrow of its principal prey, the prairie dog, while nearby the common woodchuck of the eastern United States peers watchfully over the hillsides of upstate New York.

North America has a wide diversity of natural habitats, and the mammals living in them vary as well. The nine-banded armadillo, an invader from the south, and the piglike peccary are shown in warm southwestern habitats. In cooler areas are a flying squirrel in the northern Rockies and a Kaibab squirrel on snow-laden pines in northern Arizona.

Among the other habitats displayed here are Mount Katahdin in Maine, the first place in the United States touched by sunrise each morning, Crater Lake in Oregon, the Grand Tetons of Wyoming, and Death Valley, California; these are the homes of weasels, martens, badgers, and kit foxes.

Vernay–Faunthorpe Hall of South Asiatic Mammals (Second Floor, Section 9)

In South Asia man's huge populations and wildlife have come sharply in conflict, and as a result, the future existence of many species is in doubt. In the Vernay–Faunthorpe Hall are a number of these gravely threatened mammals, including the tiger, the Indian and Sumatran rhinoceroses, the Asiatic lion, the leopard, and Eld's deer. Some have been decimated by hunting, but most are now threatened by the destruction of the habitat they need for survival. Among these are several kinds of deer and antelope, including sambar, swamp deer, and blackbuck.

Asia has also been the source of many domesticated mammals. The wild water buffalo, the gaur, and the banteng each have domestic relatives, and the Asiatic elephants have long been domesticated for use in the lumber industry and for ceremonial occasions.

Among the more unusual Asiatic mammals in this hall are the four-horned antelope and the termite-eating sloth bear.

Akeley Hall of African Mammals (Second Floor, Section 13)

Africa today is the home of vast assemblages of large and fascinating mammals. The diverse habitats—desert, forest, savannah—are occupied by particular species, some of which still occur in huge numbers. The Akeley African Hall displays the fauna and flora of many of these regions with startling and dramatic accuracy.

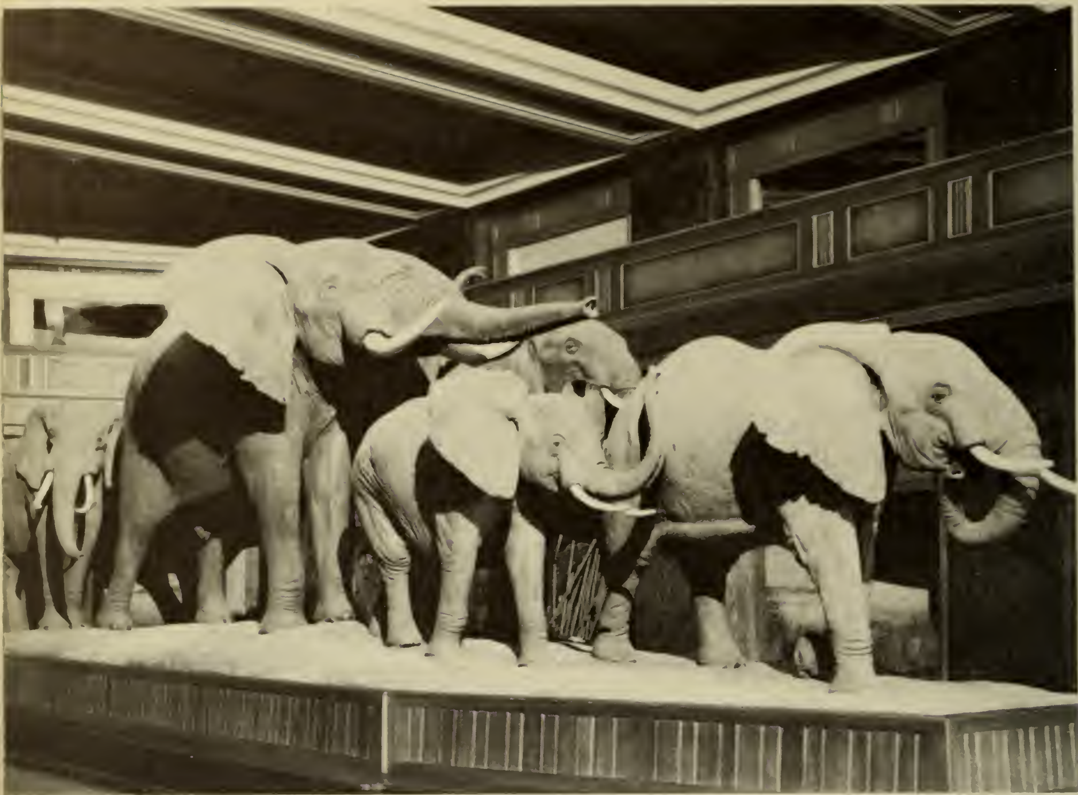
Gemsbok, once widely distributed in southern Africa, are now common only in dry parts of the Kalahari Desert (African Mammals, Second Floor, Section 13).

African lions in the Serengeti. They prefer the open country where there is long grass for cover and game is plentiful (African Mammals, Second Floor, Section 13).

Some of the numerous species of antelopes are exemplified by the greater kudu with spiraled horns, the gemsbok with its rapierlike horns, and the giant sable with gracefully curved horns. The Serengeti Plains group shows a mixture of hoofed animals in a natural gathering—zebras, eland, wildebeest, Thomson's gazelle, Grant's gazelle, topi, and Coke's hartebeest—sheltering under acacia trees to escape the midday sun.

Mountain gorillas in their high humid habitat, okapis in the low rain forest, and bongo in bamboo forest are examples of the fauna of these regions. Lions, mountain nyala, and giant eland are shown in typical habitats in drier regions. The Nile group and the water hole group each show representative species congregating to drink, including giraffes, kob, zebras, waterbuck, lechwe, and roan antelope, as well as some that make their homes in or near water such as the sitatunga and hippopotamus.

Gorilla shown in a clearing of the dense rain forest of the Kivu Mountains (African Mammals, Second Floor, Section 13).



East African elephants, alert to danger, huddle to protect the young. One checks odor with its extended trunk, while another checks the rear (African Mammals, Second Floor, Section 13).

The center of the hall is dominated by a herd of African elephants in alert formation. The great bull's trunk is raised to test the air for scent, while a younger animal wheels about to cover the rear of the herd from possible attack.

Akeley African Hall Gallery (Third Floor, Section 13)
From the Gallery of the Akeley Hall one can look down on the African elephant herd as if in a *machan*—the tree platform so frequently used for observation in Africa. Around the hall are habitat groups of many intriguing mammals, including both kinds of African rhinoceroses—the square-lipped and the black. The fastest of the cat family, the cheetah, is shown alertly watching some nyala in the background. Another cat, the leopard, stalks a bush pig at a river's edge.

Reticulated giraffes and oryxes at a water hole, where plains animals gather to drink during the dry seaso (African Mammals, Second Floor, Section 13).

Tree-living langur from southeastern Asia (Biology of Primates, Third Floor, Section 2).

At dusk several chimpanzees start constructing their nightly sleeping platforms, while deep in the central rain forest a band of bright-faced mandrills forages on the ground. In another treetop group a troop of colobus monkeys, dramatically colored black and white, feeds on vegetation.

In a South African setting, a herd of springbuck ''pronks'' by the now-rare black wildebeest and blesbok. In the Serengeti of Tanzania, scavengers assemble over a zebra kill—vultures, hyenas, and jackals will make short work of the carcass.

Hall of the Biology of Primates (Third Floor, Section 2)

Man, apes, and monkeys all belong to the same group—the primates. With mounted animals, skeletons, and diagrams, the Hall of the Biology of Primates shows the range of specialization of primates from tree shrews to man.

Lemurs and tree shrews are considered primitive primates. Lemurs are found primarily in Madagascar, and some of them, such as the aye-aye, are endangered species because their forests have been destroyed.

Of the several monkey families, two are from South America: the marmosets and the cebids. Some of the latter have a prehensile tail, most developed in such groups as the spider monkeys. The Old World monkeys have many characteristics in common that are not found in New World monkeys. They have specializations for leaf-eating and ground-dwelling, they have bare patches of skin over the bones on which they sit, and none uses its tail as a fifth hand.

The apes—chimpanzees and gorillas from Africa, orangutans and gibbons from Asia—are the primates most closely related to man. Exhibits in the hall show the evolutionary development of the structures, reproductive systems, kinds of locomotion, and habits of the primates.

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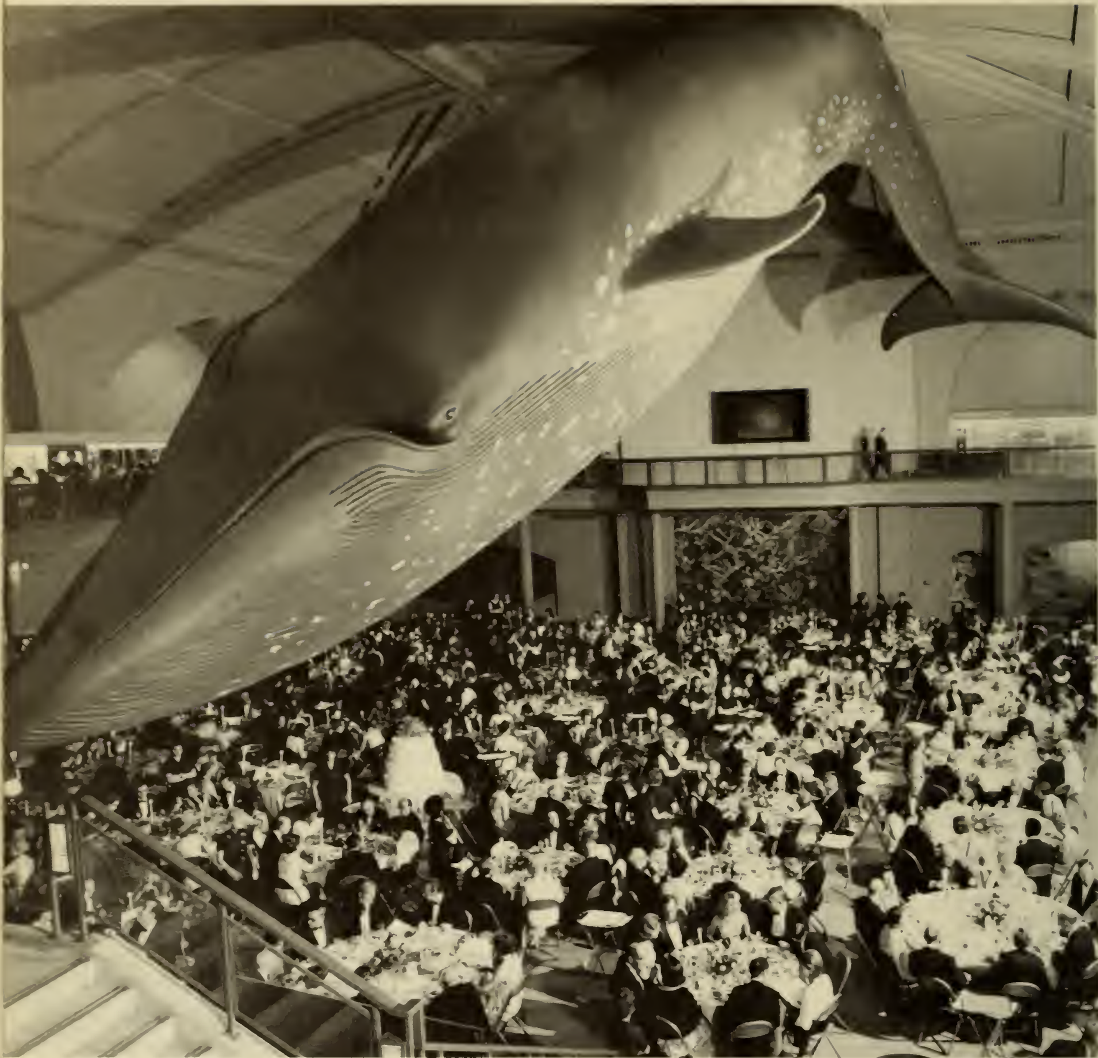


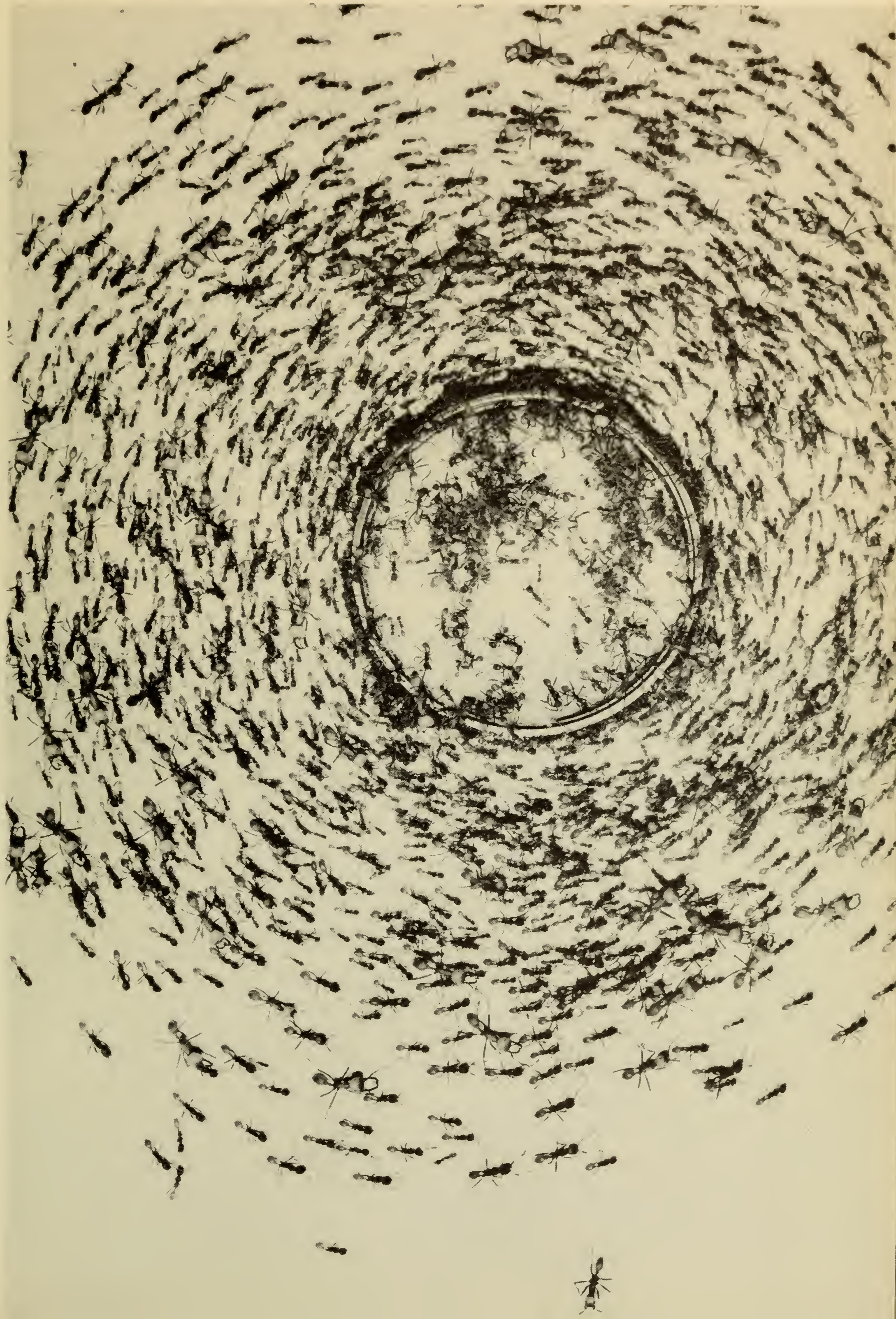
Blue whale is the largest living mammal. The model weighs ten and a half tons; a real animal this size would weigh 100 tons (Hall of Ocean Life, First Floor, Section 10).

Other Exhibits

The Hall of the Biology of Man (First Floor, Section 4) shows further details of the evolutionary development of man.

The Hall of Ocean Life (First Floor, Section 10), dominated by the great model of a blue whale, shows habitat groups of many mammals living in marine environments.

Animal Behavior



ANIMAL BEHAVIOR

Most visitors are unaware that the Museum houses a large laboratory devoted entirely to the study of living animals. This is the Department of Animal Behavior, located on the Sixth and Seventh Floors of the African Wing and on the Fifth Floor of the School Service Building. Although these areas of the Museum are not open to the general public, they are used by high-school, college, and graduate students for training in the methods of studying animal behavior. The staff of the department is also available for consultation when important problems concerning animal behavior arise.

About four decades ago, Museum authorities in their deliberations concerning Museum policy decided that while a major function of the institution would continue to be the census, classification, and structure of animals, the relationship of the various animals to each other and to their surroundings was an equally important endeavor. Museum scientists should investigate and exhibit not only what animals do, but also why and how they behave as they do. Thus the Department of Animal Behavior was established so that specialists in animal psychology and biology could study these aspects of natural history, be available for consultation in the planning of new exhibits, and participate in various training programs.

Hand-feeding a mealworm to a starling. The bird was taking part in an experiment on vision.

Much can be learned by the scientist when he observes how animals behave in their natural surroundings. Field studies, however, have very definite limitations. It is generally difficult, for example, to rearrange the surroundings so that a given aspect of behavior can be studied reliably. Laboratory study offers an opportunity to follow up, to supplement, or to correct ideas developed in the field. Also, many important problems must be brought into the laboratory if they are to be studied at all. For example, some species of fish live in water so muddy that they can be seen only when the seine brings them to the surface. They can be collected in the field, but their way of life remains hidden except to laboratory study. For reasons such as these, the Department of Animal Behavior has a laboratory designed to keep animals alive and in good health so that their behavior can be observed and analyzed under suitable conditions. A large greenhouse situated on the roof has aquariums for warm-water fishes and facilities for other tropical animals. There are nest quarters for birds; there are rooms with controlled lighting so that animals can be placed in reversed daylight cycles—thus nocturnal animals can be studied during the day. There are special heat- and humidity-controlled rooms and other means of regulating surroundings to meet the conditions needed for each type of animal and problem.

Scientist examines a male mouth-breeding fish used in studies of reproductive behavior.

The departmental program is focused upon the important problem of behavior development in the individual and in the species and upon the evolution of behavior. Physiological mechanisms involving brain, nerves, glands, and hormones are studied along with social factors, previous experience, and the general influence of an animal's surroundings upon its behavior. All of these affect the animal's behavior to some extent—the question is how. Somewhat as the evolution of animals is reflected in changes from simple to more complex structures, we find among animals an evolution of behavior from the simple, forced movements characteristic of one-celled forms to the elaborate behavior patterns and mental capacities characteristic of mammals and man. For a proper understanding of the evolution of behavior it is necessary to study a variety of behavior patterns in very different animals. Thus, as the departmental program progresses, living quarters are provided for many types of animal under study, including mollusks, insects, fishes, amphibians, birds, and various species of mammals.

Gray spiny-backed mice in a simulated environment in the laboratory. These mice are born at an advanced stage of development, unlike laboratory or house mice, to which they are related.

Anthropology

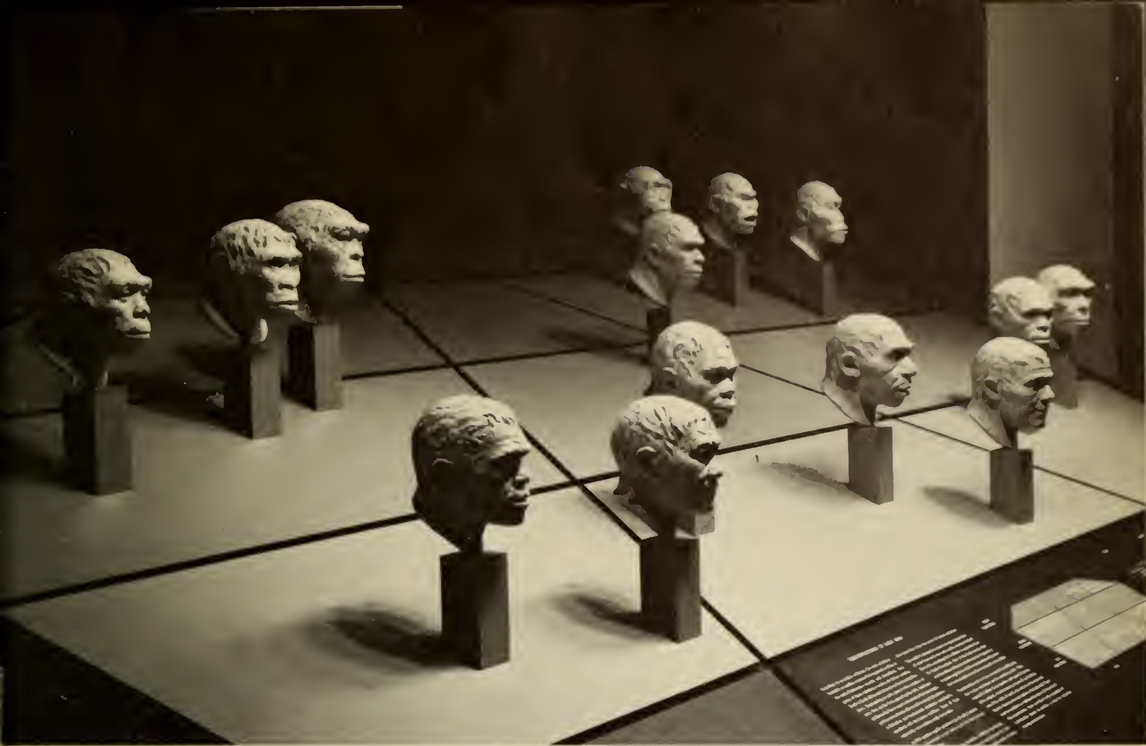
ANTHROPOLOGY

Anthropology is both a natural and a social science in that it deals with man as a biological and as a social creature. To treat the various aspects of so vast a subject, the field is divided into four scientific disciplines: physical anthropology, archeology, ethnology, and linguistics.

Physical anthropology studies man's evolution, the classification of the past and present racial variations of man, and all aspects of human biology. It studies the cultural and environmental factors that shape the physical characteristics of a population. Ethnology is the science of culture, that body of learned behavior including all of man's knowledge, beliefs, and customs, his social organization, institutions, and crafts. Archeology analyzes the artifacts of ancient cultures. Working with objects whose material is imperishable, such as tools, pottery, and building foundations, the archeologist attempts to reconstruct cultures of remote times. The fourth specialty, linguistics, is the scientific analysis of language and the laws controlling it.

While these four fields are separate, they are closely interconnected. They augment and amplify each other, while offering four perspectives upon their common subject, man. The research interests of the anthropologists on the Museum's staff reveal the breadth of the field. They range from the study of man's prehuman ancestors to an investigation of the Indian caste system as it relates to certain sociological and economic factors. They include the ancient cultures of Mexico and Peru, as well as the primitive cultures of today, and the effect upon them of increasing contact with modern civilization.

Baby is born head-first through the narrow pelvic opening into a doctor's hands (Biology of Man, First Floor, Section 4).



Heads of man's ancestors show the changes of skull structure. The heads are reconstructed from fossil fragments and therefore the features can only be surmised (Biology of Man, First Floor, Section 4).

Biology of Man (First Floor, Section 4)

The Hall of the Biology of Man presents man as a species—his relationships to other members of the animal kingdom, his evolutionary history, and his functions as an organism.

Man belongs to the zoological order of primates, which also includes prosimians (lemurs, lorises, and bushbabies), monkeys, and apes. The order falls into the larger categories of mammals and vertebrates. The earliest primates presently known existed in the last part of the Cretaceous Period, at the time of the last dinosaurs (64–60 million years ago), but their fossil remains consist of no more than a few teeth. The earliest primate of which some anatomical knowledge is known is *Plesiadapis,* a primitive form that lived in North America and Europe during the Paleocene (64–58 million years ago). *Plesiadapis* was rather squirrellike in many of its adaptations and possessed front teeth similar to those of modern rodents.

During the Eocene (58–36 million years ago) much more modern primates lived, in many ways similar to the present lemurs. By Oligocene times (36–25 million years ago) the first of the higher primates had appeared. All the fossils of Oligocene higher primates were found in the Fayum depression in the Egyptian desert, which contains both monkeylike primates and a primitive ancestral ape.

The ancestors of the modern apes were well established by the Miocene (25–14 million years ago), but not until the very end of the Miocene and the beginning of the Pliocene (14–5 million years ago) were there primates that can be included in the zoological family of man, Hominidae. Only fossil fragments of this form, *Ramapithecus*, have been found, but the pieces of jaws and teeth show that *Ramapithecus* is of, or close to, the ancestry of man. Comparative studies of these early teeth and jaws and living primates show that the line leading to man probably differentiated from that culminating in modern apes because its members adopted a new set of feeding habits, especially in that they ate small, tough morsels that required strong teeth for grinding before ingestion. It is unlikely that *Ramapithecus* was an erect biped; certainly the enlargement of the brain that characterizes modern man took place at a much later date.

A few remains of *Australopithecus* from the beginning of the Pleistocene (about two million years ago) have been found in South and East Africa. *Australopithecus* probably walked erect, but its brain was much smaller than man's (about 500 cubic centimeters, the size of a modern gorilla). It manufactured stone tools, an important step in development.

At some time during the Middle Pleistocene (less than a million years ago) members of man's genus, but of a different species, began to appear. Brain size has grown since *Homo erectus,* but the oldest remains of his limb skeleton are virtually indistinguishable from those of modern man. Men of the "Neandertaloid" type existed later, with large brains but still possessing archaic skull features. The picture of the emergence of modern man is still unclear, but men of a completely modern type appear to have evolved in the Near East and spread into Europe about 30,000 years ago. Human occupation of North America was much more recent.

Man as a biological organism is discussed in detail in the hall. Man is made up of combinations of different kinds of cells, which have different functions. The resultant systems interact and function to maintain a viable human being. The muscles and skeleton together provide support and protection for the body, and the ability to move. The nervous system, controlled by the brain, controls responses to stimuli of all sorts—including the senses, sight, hearing, touch, smell, taste.

Man has many glands, which together form the endocrine system. Glands send out secretions called hormones to various parts of the body to regulate the development and functioning of the organs. The pituitary gland controls many functions, especially physical growth and sexual development. Other important glands are the thyroid, the pancreas, the adrenals, and the gonads.

The digestive tract is composed of a long tubelike structure and various accessory organs. The muscular action and the chemicals of the stomach break

ansparent model of a woman showing the internal organs and structures
iology of Man, First Floor, Section 4).

down food, sending what remains through the intestines. Nutrients are absorbed into the bloodstream, wastes are sent to the bladder and lower intestine for excretion. The kidneys and liver aid in these processes.

Through the respiratory system, air is taken into the lungs and oxygen is sent into the bloodstream. The circulatory system sends oxygenated blood, pumped by the heart, to all parts of the body, where the oxygen and nutrients are used and the blood is sent back for replenishment.

All of these body functions are detailed in the hall, and the various systems are brought together in their anatomical context by a transparent model of a woman, in which all the components are precisely located.

Human reproduction is accomplished by the joining of a male cell (sperm) with a female cell (ovum). The embryo grows in the female uterus and is born after forty weeks. The hall shows the stages in this intrauterine development and shows how the baby is born.

Other Exhibits

The Hall of Primates (Third Floor, Section 2) shows the immediate ancestors of man.

Enlarged cross section of a kidney, showing the fine network of capillaries and nephrons, necessary for filtration (Biology of Man, First Floor, Section 4).

Bronze sculpture from Dahomey in west Africa. A court procession is accompanied by a band playing musical instruments (Man in Africa, Second Floor, Section 1).

Man in Africa (Second Floor, Section 1)

Although the Man in Africa Hall deals largely with the past, it can help to give a better understanding of the present by showing the heritage that remains and influences the character of new nations and that, in the New World, gives Afro-Americans an individuality of their own.

Present evidence suggests that man had a very early beginning in Africa more than two million years ago and may have first appeared there. As man's brain developed, his cultural behavior began to specialize, and he started to make tools. He had to adapt to the environment in order to serve his own needs, and his social evolution resulted in response to this adaptation. A band of men, which is small and able to change composition and size, best meets the needs of a hunting, nomadic society, where the family is the only social unit. When man begins to cultivate land, his whole social life changes radically because he settles in one place. Africa has such a multitude of environments that adaptation to them took on many forms. Man had to relate to the desert, the forest, the grasslands, and the river valleys. The hall is separated into sections dealing with each of these.

The nomadic existence on the desert depends on seasonal variations that

Berber desert nomads, who live near the Atlas Mountains of Morocco (Man in Africa, Second Floor, Section 1).

may place water and food sources far apart. Water shortage has led to several forms of cooperative organization, as has the unifying influence of Islam, which has spread far since the Holy War in the seventh century. Nomadic Kalahari Desert Bushmen are shown in the hall. Their severely simple life sharply contrasts with the richness of their dream world.

The rain forest stretches from coastal Guinea to the central Congo and the edge of the eastern grasslands. The first hunters and gatherers in this area lived in harmony with the forest. Later immigrants, accustomed to open country, felt threatened by the forest and cut it down to allow sunlight to reach their crops and ward off evil. Men living in the forest rely on many aspects of spiritualism to give meaning to their lives. Kings rule by virtue of descent from semidivine ancestors. Masks and other sacred objects impart power through divinity. Music is the prime means by which the living can commune with the spirit world. Dance reinforces traditional beliefs and values, even on occasions that appear purely festive. Magic is a science, both for prevention of harm and for its cure. Tribal doctors know many effective medicines, and even their "charms" are helpful because they offer a needed sense of security to the

Pygmy youths from the Congo area will not grow to more than four and a half feet tall. They live and hunt in traveling bands (Man in Africa, Second Floor, Section 1).

patient. Different objects showing the spiritual aspect of African life are shown in the hall.

Farming in the forest is arduous, as new fields must be cleared. But organization is not required, and so the villages are autonomous. Common crops such as manioc, beans, plantains, and peanuts deplete the fields in two or three years. Because of their oil palm cultivation, which does not deplete the soil, the Mangbetu have retained the centralized state organization with which they settled their area over 1000 years ago.

The Bira and the Lele fear the forest as a hostile world that perpetually hinders their efforts at cultivation. To defend themselves against competing neighbors and evil forest spirits, they use magic, witchcraft, and sorcery. Ritual propitiation of the forest, and the water in the case of fishermen, is vital for cultivation and hunting.

One diorama shows a band of Mbuti pygmies, where each member of the group has a specific job depending on his age and sex; the hunting and gathering is a cooperative effort.

The grasslands, mostly in east and south Africa, were formerly occupied by nomadic hunters. The land is now divided between farmers and herders, each scorning the other's way of life. Herders usually remain loosely organized, whereas the cultivators have sometimes organized into powerful, complex states.

Traditional African society is based on kinship—from the family to the clan to the tribe, with a single imaginary ancestor. A strong central authority rose with an expanding population and an increasingly complex social organization based on agriculture. The chief eventually becomes king. Women have an important place in farming, government, and ritual, where they are the diviners and doctors who influence the fertility of the earth. Economic and political prestige and authority are enjoyed by women all over Africa. Inheritance is frequently through the female line. A large exhibit details the role of women.

A group of grassland herders, the Pokot of northwest Kenya, are shown bleeding a calf. The blood is used for food.

Africa's river valleys have always been important. Civilizations flourished along the Nile, the Niger, the Congo, and the Zambesi because the rivers simplified trade and travel and the rich riverbanks produced surpluses for the settled farming communities leading to economic specialization and political expansion. Behind a facade of autocratic rule, the Niger kingdoms were essentially democratic. Along the Zambesi the Zulu state developed mostly through conquest, and the Lozi grew more gradually through riverine farm bases.

States rose in the Congo Basin bringing unity and peace, cultivating the arts, and creating splendid royal courts. Dynastic Egypt on the Nile relied on agriculture with a good annual surplus to support the many nonfarming groups such as priests and craftsmen. Pharaoh was deified but was outside the social

Bira man paints his body to resemble the sacred leopard for a male initiation ceremony deep in the forest (Man in Africa, Second Floor, Section 1).

Masks are used for many functions, usually to symbolize a person, animal, god, or emotion. Shown here is a Senufo mask used for rites in a women's society (Man in Africa, Second Floor, Section 1).

hierarchy that characterized the state. Social mobility was common, and men of humble origins often rose to key posts. Ethiopia is a Christian country, but the religion has retained its archaic form somewhat resembling Eastern Orthodoxy. Regionalism and warfare, due to rough, irregular terrain, marked Ethiopian development until unity in the nineteenth century.

Africans transported to the Americas as slaves brought elements of African culture with them, and some traditions are still apparent today in the southern United States. The institution of slavery in North America tried to undermine African tradition by dividing families and destroying cultural patterns. However, much of what is African, particularly the broad concept of family with its focus on the mother, has been retained by the Black American as part of his own identity.

Other Exhibits

The Akeley Hall of African Mammals (Second Floor, Section 13) shows the variety of landscapes and animals found on the African continent.

Peoples of the Pacific (Fourth Floor, Section 8)

The Hall of the Peoples of the Pacific shows the remarkable diversity of cultures found in the South Seas. The people of these areas may once have been related, but their geographical distance from one another led to great variations. The main cultural areas represented in the hall are Polynesia, Micronesia, Melanesia, Australia, Indonesia, and the Philippines.

Polynesians, "people of the many islands," was the name given by European navigators to the tall, golden-skinned people found on every habitable island from Hawaii in the north to New Zealand in the south and Easter Island in the east. Polynesian origins have long been a subject of controversy. Earlier theories of their voyages from the Asian mainland or from the Americas have been replaced by the current feeling that they developed some 2000 years ago in eastern Melanesia and were subsequently dispersed.

Polynesian groups were remarkably similar both racially and culturally. Many had been separated for so long that they did not know of each other's existence, yet many spoke mutually intelligible languages and shared the same myths. Such myths attributed their origins to an emergence through a long series of births from paired personifications of natural forces or to long evolutionary sequences.

Masks made of local materials from New Ireland, an island of the Bismarck archipelago east of New Guinea (Peoples of the Pacific, Fourth Floor, Section 8).

The basis of social organization was descent groups, and chieftainships were based on genealogical descent and relationships to sacred places of the ancestral gods. Political organization responded flexibly to differences in land and population sizes. Gods and men, objects, and descent groups were ranked and had *mana,* supernatural efficacy, in different degrees. A system of *tapu*—from which the English word *taboo* derives—governed the respect demanded for them. Polynesian religion was based upon a belief in an ordered universe; if the order were violated, disaster would result, if it were observed, prosperity would reign.

Technology was primarily based on wood, with a great dependence on the coconut palm. Material for clothing was made of the beaten bark of the paper mulberry. Yams, taro, and sweet potatoes were grown with only a digging stick for a tool. Clubs, spears, and axes were used in warfare.

There was some variation of the homogenous culture patterns of the people. Each island culture had its special extravagances: the enormous stone statues of the Easter Islands (a cast of one is at the back of the hall); the clubs and paddles of the Cooks and Australs that were carved beyond the possibility of use; the feather capes of the Hawaiians, woven of pairs of wing feathers plucked

Black snake totem burial ceremony of the Warramunga tribe in Australia (Peoples of the Pacific, Fourth Floor, Section 8).

from individual birds that were then released; the elaborate Samoan kava ceremonial; the dried tattooed human heads from New Zealand. All of these are shown in the hall.

Micronesians, "people of the small islands" (about 2500 islands west of Polynesia and north of Melanesia), are a brown-skinned people much more diversified than the Polynesians. Status defined by well-established lineage was the political base, with descent rigidly fixed through the female line. Leadership was vested in membership in high-ranking lineages. Land was owned collectively by descent groups or, in cases of unused land or unlimited reefs or lagoons, by districts. Scattered homesteads or small hamlets were the rule.

The inhabitants of the high islands—Saipan, Truk, Ponape, Guam, and some large islands like Yap—had fertile land and ample resources for farming and fishing. Those who lived on the low islands—the tiny windswept atolls—depended more on fishing and coconuts.

The coconut had many uses. Dried coconut meat was drained of oil, making copra, which was used for cooking. Copra-making is now a substantial industry in the Pacific—the oil is also used as a cosmetic base. The fibers of the coconut were braided into rope called sennit.

Melanesians, "black islanders," was the name given to the dark-skinned peoples of New Guinea and surrounding islands, east as far as Fiji and north to the Bismarck Archipelago. Nowhere else is there such diversity of culture, language, religion, and physical type. New Guinea itself has a population of about two million people speaking more than 500 different languages, and the rest of the area numbers only another two million.

Political authority rarely extended beyond very small units of clan, ward, or village. "Big Men" achieved status through mobilization of food for extensive feasts. Magic and sorcery were highly developed, and the division between men and women was particularly strong. Pigs formed the basis of feasting and wealth, except where turtles and large sea mammals were sometimes available. Beyond such similarities, the differences in the cultures were staggering. Some aspects of many of them are shown in the hall.

A scale model of Pere, a village in Manus, is a microcosm of one of these culture patterns. It shows the fishing village exactly as it appeared in the 1920s. The people have since moved from living in stilt houses in the lagoon to houses on the land.

The first aborigines settled in Australia at least 26,000 years ago, having traveled over water from Southeast Asia. They have always hunted, especially with the boomerang and spear-thrower, and collected wild foods rather than farmed. Group decisions, particularly when involving conflicts and marriage arrangements, are made largely on the basis of known kin relationships, which also guide daily decisions about sharing food and locating camps.

All Australian aborigines share a belief in sorcery, and most groups have

Hawaiian feather cape. The crescents represent the rainbow, symbol of the aristocrats who wore these capes (Peoples of the Pacific, Fourth Floor, Section 8).

Wooden feast bowl carved by Maoris in New Zealand (Peoples of the Pacific, Fourth Floor, Section 8).

individuals who practice white or black magic or both. The people have a variety of rituals, myths, music, and visual arts. Myth is fused with religious life, so that many rituals are reenactments, set to song and dance, of mythical events.

The two great archipelagic regions of Indonesia and the Philippines have contributed significantly to the long, complex history of Asia. Today, almost all the area of the two archipelagos makes up the modern republics of the same name. In the past, the peoples shared the same traditions, which have now evolved into ones specific to the various regions.

Many aspects of their life style are similar. Agriculture has long been practiced, especially cereals and root crops. Rice, grown both in dry fields and on irrigated terraces, is the staple food. Rice cultivation provided a base for specialization of work, stratification of society, and elaboration of architecture and ceremonies. Religion was characterized by a close communication between the spirits of the living and the dead. Social differentiation was determined by wealth and family rank.

Such implements as the kris and bolo were common throughout, with both Indic and Islamic styles of manufacture and design. Textiles, especially the batik process, were important both economically and culturally. Examples of these arts are on display.

The peoples of the Pacific are still sharing many cultural and economic similarities. They are all facing the impact of Western civilization and its encroachment on traditional values.

Other Exhibits

Landscapes of many of the Pacific Islands are shown in the habitat groups of the Hall of Oceanic Birds (Second Floor, Section 19).

Shadow puppet from Bali. Made of leather, such puppets cast their shadows on a screen during dramatic presentations (Peoples of the Pacific, Fourth Floor, Section 8).

Eskimo (First Floor, Section 7)

The Eskimo live in small groups scattered over the arctic and subarctic coasts and islands of Greenland, Canada, Alaska, and the eastern tip of Siberia. They now number less than 40,000. The earliest known Eskimo ancestors lived on the shores of the Bering Sea at least 5000 years ago. Their cultural remains, consisting of hundreds of small flint tools discovered at Cape Denbigh, Alaska, are known as the Denbigh Flint Complex. The principal roots of modern Eskimo culture rose in the Bering Strait region of Alaska about 2000 years ago. The Thule phase of Eskimo culture developed about 1000 years ago on the arctic coast of Alaska. It spread rapidly across arctic Canada to Greenland, resulting in considerable similarity of Eskimo customs and language.

The traditional culture portrayed in this hall is a way of life that existed until the nineteenth and early twentieth centuries. It has since changed in many ways due to contact with the dominant cultures of Denmark, Canada, the United States, and Russia. Characteristic traits of that culture are a response to the challenge of the harsh arctic environment—dependence on sea mammals, use of dogsleds and skin-covered boats, a religion centering on the powers and rites of shamans, and other traits depicted in the hall.

Interior of a Copper Eskimo snowhouse. Air is heated as it rises to the platform where the occupants live (Eskimo, First Floor, Section 7).

The Eskimo tribes of Canada, with the exception of the Mackenzie, are collectively called the Central Eskimo. The Yuit, Alaskan, and Mackenzie are the Western Eskimo, and the Greenland Eskimo are lumped together. There are some cultural differences among the groups, but the similarities are more important.

The Eskimo lead migratory lives because of the effect of seasonal variations on game, on which they rely for almost all aspects of life. Sea mammals and caribou are used for food and clothing. Seals are harpooned from kayaks or through their breathing holes in the ice; walrus are lured to the edge of the ice; caribou are driven toward concealed hunters or into a lake or river where they are killed with lances. Kayaks, an excellent example of which is shown in the hall, are made from pieces of driftwood and walrus hide. The Greenland and Western Eskimo made special waterproof clothing and fitted the jacket over the rim of the manhole of the kayak; the boat could be overturned and righted again without shipping water.

Dogsleds are used for traveling overland in winter. The runners of the sled are glazed with ice to reduce friction. The Central Eskimo live in snowhouses in winter; the Western and Greenland Eskimo use them as temporary shelters erected when traveling. A Copper Eskimo snowhouse model is in the hall. Fresh air enters the house through an entrance tunnel and rises to the level of the lamp where it is warmed. Stale air is released through a small hole in the roof. Thus, while the air at floor level is well below freezing, it is

Eskimo art made of soapstone and ivory from a walrus tusk (Eskimo, First Floor, Section 7).

reasonably comfortable on the platform where people sit, work, and sleep. A block of freshwater ice is used for a window. Polar Eskimo houses of northern Greenland are made of stones covered by sod and another layer of stones. They are heated in the same way as the snowhouses.

Traditional household utensils are made of various parts of sea mammals. Perhaps the most ingenious is the blubber lamp, an adaptation to an environment where wood is scarce. The lamp itself is made of soapstone. The heat from a lighted moss wick on the front edge of the lamp melts blubber placed to the rear, and oil flows forward to the wick.

Most Eskimo clothing is made of caribou and seal skins. Caribou skins are preferred because they are strong, light, and have excellent insulating qualities. In winter the Eskimo wear an inner and outer set of clothes, generally similar in construction except that the inner set has hair facing inward to maintain a layer of warm air between the wearer and the outer wall of the garment. In summer the outer set is taken off.

The distinctive skill of the Eskimo craftsman lies in his ability to produce weapons, clothing, boats, and other articles to cope with an extremely difficult environment using sparse raw materials and a few simple tools. Raw materials consist chiefly of pieces of driftwood and animal products such as bone, ivory, sinew, and hides. The joining together of small pieces of wood and bone by skillful pegging and lashing is characteristic of Eskimo craftsmanship. Carvings in stone, bone, ivory, and wood are known from prehistoric periods, but the production of sculpture increased on contact with Europeans who, appreciating their artistic and exotic nature, purchased them. Modern Eskimo produce sculpture and other works of art of noteworthy quality.

Eskimo religion reflects the uncertainty of the food supply. Important deities, as well as the souls of animals, are believed to control the supply of game, and must be placated to assure success in hunting. Masks and drums are used in religious rites, and several are shown in the hall.

Eskimo adaptation to a harsh environment involves a knowledge of nature and a set of techniques that have been developing for millenia. This traditional way of life is rapidly changing and nothing can save it. The Eskimo may survive and grow as a people, but the archetype of the self-reliant hunter living solely on the meager resources of the Arctic is from another era; it has disappeared in this one.

Other Exhibits

The marine mammals on which the Eskimo depended are shown in their icy habitats on the lower level of the Hall of Ocean Life (First Floor, Section 10). Some of the land mammals are shown in the Hall of North American Mammals (First Floor, Section 13).

Haida canoe hollowed from the trunk of a cedar tree (First Floor, Section 2).

Northwest Coast Indians (First Floor, Section 1)

The major part of the Northwest Coast geographic and cultural area lies along the coast of Canada and Alaska. The climate is mild, though, because the entire area is warmed by the southward-flowing offshore Japan Current. The seasonal rainfall is heavy, forests are dense, and there are many streams. The Indians who lived in the area shared many of the same cultural traits, and the hall points out these similarities, as well as the differences. The tribes of the area depended greatly on the wood and bark of the cedar tree for many uses, especially houses and canoes. The great 64½ foot Haida war canoe in the Seventy-Seventh Street Lobby was hollowed from the trunk of a single cedar tree. Canoes of this size were used for war parties or for making ceremonial visits. The figures represent a chief of a neighboring tribe, the Chilkat, with his followers coming to share a feast. The paddlers are slaves from other tribes of the region.

With their extraordinary skill in woodworking, Indians of the Northwest Coast made towering wood totem, grave, and house poles that are unique in aboriginal North America. The same skill, which produced original artistic stylizations, is found in the weaving, basketry, and carving of stone and ivory. Their clothes were woven of cedar bark, and the wood from these trees was used for many everyday objects.

The Indians had an abundance of food in the ocean and streams and growing wild, and thus did not practice agriculture; dogs were the only domesticated animals. The Indians were very dependent upon fishes and sea mammals for food. They had many religitous rites directed toward spirits of the sea, and they held a series of elaborate religious dramas during the winer.

The Haida inhabited the Queen Charlotte Islands and the southern part of Prince of Wales Island, Alaska. The Haida were almost totally dependent upon the sea, which was reflected in their religion. Most of their prayers and offerings were directed toward the "Ocean Beings," who were believed to embody themselves in fishes and sea mammals and thus affect the food supply.

The Haida traveled by sea from one end of the Northwest Coast to the other, adopting customs of other tribes. They had a unique skill in their carving of slate, however, into beautiful boxes, pipes, and miniature totems.

The Tsimshian lived on the mainland of British Columbia, mainly on the Nass and Skeena Rivers. They became noted traders because they lived in a strategic location. The Tlingit to the north were the source of copper for the Northwest Coast; the Kwakiutl to the south traded slaves and the coveted dentalium shells; the Haida had sea otter furs.

The Bella Coola lived on the upper reaches of Dean and Burke channels and the lower parts of the Bella Coola River in British Columbia. Their principal food was salmon, but berries, abundant in the summer, were pounded into a pulpy mass, dried in the sun, and eaten in the winter.

Totem, grave, and house poles along the hall show grotesque human and animal forms (Northwest Coast Indians, First Floor, Section 1).

Thompson women weaving a basket (left) and preparing the hide of an elk (right) (Northwest Coast Indians, First Floor, Section 1).

The Thompson and Lillooet belonged to the plateau culture area to the east of the Northwest Coast. Culturally, these tribes were very different from those of the Northwest Coast. They ate land mammals, used less wood, and wore clothes of animal skins. Social and religious organization was much less elaborate than that of Northwest Coast tribes. The Lillooet were the intermediaries in the trade between the Northwest Coast and the interior, and thus were exposed to Northwest Coast culture patterns, some of which they adopted.

A number of Salishan-speaking tribes inhabited the Northwest Coast from the Gulf of Georgia south to Oregon. All the tribes (the Comox, the Cowichan, the Klallam, the Quinault, the Snuqualmi, and the Twana) had cultural traits characteristic of the Northwest Coast to varying degrees.

The Tlingit occupied the southeastern coast of Alaska from Yakutat Bay to British Columbia, except for the southern part of Prince of Wales Island, which was inhabited by the Haida. Slavery was prominent among the Tlingit; about one-third of the population was Coast Salish slaves. Tlingit ceremonies centered around the stages in the life of noble people, such as receiving names, coming of age, etc. Elaborate potlatches (a general term for a variety of ceremonies) were held, where a huge amount of valuable property would be destroyed or given away. In this way an individual would acquire social status for himself and his family. Although temporarily pauperized, he would soon become richer because gifts had to be returned with interest.

The Kwakiutl lived on the northern part of Vancouver Island and in adjacent areas. An outstanding feature of their culture was the Winter Ritual, an elaborate four-month ceremony that gained for uninitiated youths the protection of a supernatural being. Upon initiation the youths became members of the secret society, which was probably started by the Kwakiutl and spread throughout the Northwest Coast.

The Nootka lived in independent villages on the west coast of Vancouver Island. No single leader or tribal council ruled them, but villages often united into confederacies for war or defense. Fishes and sea mammals were the basic food, but the Nootka were one of the few tribes that hunted for whales. Paintings of family gods and ancestors were executed on house fronts and board screens inside the houses of chiefs and heads of families; they were displayed only at ceremonies.

Today the culture of the Northwest Coast Indians has largely disappeared. The Indians still live in their original villages, but in modern houses. They work in the local industries—fishing, lumbering, and canning. Many of their wooden artworks, especially the totem poles, have simply rotted in the wet weather.

Indians of the Plains (Third Floor, Section 4)

The Plains encompassed the territory from Canada to Texas between the Rocky Mountains and the Mississippi River. It was the home of such tribes as the Sioux, Apache, Blackfoot, Mandan, and Arapaho. The ancestors of the Plains Indians had inhabited the region for 10,000 years before the coming of the Europeans. The historical tribes were primarily hunters of the large herds of buffalo that were then plentiful. In the Eastern part of the area they also practiced agriculture.

The Spaniards brought the horse to the New World and by the seventeenth century had established stock-raising settlements. The Indian tribes living nearby learned about horses, their equipment, and the techniques necessary for their use. The horse revolutionized buffalo hunting for the Indians. Instead of chasing the animals on foot, they were now able to pursue the herd on horseback. They also had greater mobility, as the horse could transport household equipment over long distances. Thus a new way of life was established, based on the horse and the hunting of big game, that reached its peak early in the nineteenth century. Then, as the European settlement extended westward, the efficient buffalo rifles of the newcomers drastically reduced the herds upon which the Indians depended. The tribes were economically decimated by the near extermination of the buffalo.

Nomadic tribes lived in tipis the year round. Farming-hunting tribes lived in tipis when following buffalo in the summer; the rest of the year most of

Crow Indian costume made of skins and decorated with porcupine quills (Plains Indians, Third Floor, Section 4).

them lived in earthlodges in permanent villages. A tipi housed a man, his wife (or wives), and children. It consisted of a semicircular cover of about fourteen buffalo hides placed over a framework of about nineteen poles arranged to form a cone. The earthlodge was a dome-shaped structure forty to fifty feet in diameter. More permanent than the tipi, it lasted from seven to ten years and housed several related families.

The nomadic tribes of the Plains lived almost entirely on buffalo meat, which was often made into pemmican, a preparation of meat, fat, and chokecherries. The skins of buffalo and other animals provided clothing until the late nineteenth century, when commercial cloth was used.

The art of the Plains Indians is represented by the quill and beadwork with which they decorated the objects used in daily life. The women were skilled in creating geometric designs of porcupine quills and glass beads (obtained from Europeans), while the men painted realistic scenes of warfare on skins.

Ritual ceremonies were an important part of Plains Indian culture. Aspects of many of them are shown in the hall, such as in the diorama of the ceremonial Blackfoot tipi, where the Indians are participating in the Thunder Pipe Ceremony. The Sun Dance was celebrated annually by most tribes, usually during the tribal gathering for the summer communal buffalo hunt. The calumet, a widespread institution in the Plains, was a reed decorated with feathers. When given by one person to another the calumet symbolized adoption. The term came to be applied to the pipe that was smoked at the conclusion of a peace treaty, the peace pipe. The Wawan, the calumet ceremony of the Omaha, is shown in the hall.

The shaman, or medicine man, played an important role among the Plains Indians, who believed that success could be gained with the help of supernatural power obtained in a vision or dream. To receive such a vision, people went to isolated places where they fasted, prayed, and sometimes cut off part of a finger to gain the sympathy of a supernatural being, who would bestow powers, such as the ability to manipulate the weather, to predict the outcome of battle, or to cure disease. Most shamans used their powers to benefit others, but some engaged in sorcery.

Music was a part of most Plains Indian activities. Singing, accompanied by drums and rattles, was essential to the exercise of supernatural powers. Indians sang at religious ceremonies, at social dances and games, and to prepare for war, hunting, and the planting of crops.

Most Plains Indian tribes had several men's organizations. The function of these societies was to foster a spirit of daring and courage in warfare. The ceremonies of some societies were primarily religious and were believed to contribute to the tribal welfare. In a few tribes the women had similar societies.

Ceremony to the god Thunder at an alter in front of the fire in a Blackfoot tipi (Plains Indians, Third Floor, Section 4).

Before the introduction of the horse, Plains Indians hunted buffalo on foot, often by driving a herd over a cliff (Plains Indians, Third Floor, Section 4).

Games played by the Indians included foot and horse racing, archery contests, and gambling on all contests, where the stakes were frequently high.

The nomadic hunting life of the Plains Indians led to frequent intertribal contacts. Because they spoke different languages, they developed an efficient system of sign language. Warfare among the tribes was common, however, and winning war honors was as important as the practical concerns of defense or the capture of booty. Each tribe recognized a graded series of courageous deeds, known as coups, such as taking a life or scalp or stealing a bow or horse. The greater the number of coups to his credit, the greater a man's prestige.

The present life of the Plains Indians, whose numbers are now increasing after a period of population decline, differs radically from that of buffalo days. Many Indians now participate successfully in every aspect of American life, but some, handicapped by poverty and inadequate education, have not. The transition from a nomadic hunting culture to full participation in a modern industrial society has been difficult.

Other Exhibits

The landscapes and animals among which the Plains Indians lived are shown in the Hall of North American Mammals (First Floor, Section 13).

Eastern Woodlands Indians (Third Floor, Section 4)

The Hall of the Indians of the Eastern Woodlands portrays the life of the American Indians who lived in the wooded eastern parts of what is now the United States and Canada. The first settlers, known as paleoindians, lived about 12,000 years ago. They hunted big game and probably lived in small nomadic bands. The paleoindian period was succeeded by the archaic period, when Indians still depended upon hunting and gathering, but with improved hunting implements such as the atlatl, or spear-thrower, and the bola.

During the burial mound period (1000 BC to 800 AD), the Indians became farmers as well as hunters, cultivating the principal New World crops—maize, beans, and squash. There was considerable artistic development, as shown in pottery and carved stone pipe, especially during the Hopewell culture (500 BC to 500 AD) of the Ohio and Mississippi valleys.

The period of the temple mound builders (900 to 1500 AD) was characterized by ceremonial centers featuring a high mound surmounted by a temple. In the final phases of this period, which ended with the beginning of European settlement, the Indians began to live in compact walled towns, indicating a time of hostility between tribes.

When the first European explorers arrived on the eastern seaboard at the end of the fifteenth century, Indian culture was flourishing over all the Eastern Woodlands. In the succeeding 350 years many of the tribes were annihilated by disease and warfare; others were driven west of the Mississippi River. A few tribes were later assigned to reservations in their aboriginal territories.

Many aspects of the daily life of the Eastern Woodlands Indians are illustrated in the hall. One of the best-known artifacts was the birchbark canoe. It was ideal for traveling in the heavily wooded and well-watered northern parts of the Eastern Woodlands. Light enough to be carried easily on men's shoulders and drawing only a few inches of water, the birchbark canoe could carry two or three tons of crew and freight. Both men and women participated in making the canoes.

Most aboriginal clothing was made of animal skins, but after contact with Europeans cloth was often substituted. Women made textiles and produced designs with the spaced-weft, warp pattern method. The women also made pottery, but after the introduction of European utensils, the art of pottery-making all but disappeared.

Beads of seashells, known as wampum, were originally used in ceremonies and were woven into belts to record important events. The European settlers found that Indians would exchange furs for wampum, and it began to function as a medium of exchange. For a time wampum was legal currency in the colonies.

In the Eastern Woodlands war consisted of brief raids made by small groups of men who sought personal glory or vengeance. The bow and arrow, the club, and the knife were the principal weapons. Equally important to the Eastern Woodlands warrior was war medicine—various small objects believed to be endowed with supernatural powers.

Throughout the Eastern Woodlands, the Indians believed that shamans had the ability to control disease by the use of supernatural powers. Ceremonies, such as those given by the Iroquois False Face Society, involved curing and spiritual purification. Tobacco was sometimes smoked for pleasure, but it was considered sacred and was used mostly in religious ceremonies. Dreams played an important role in Indian life. Through dreams came hunting rituals, war chants, and other sacred messages.

The Eastern Woodlands Indians lived principally by hunting, fishing, gathering wild plants, and cultivating small farms. Although their implements were simple, hunters and fishermen had an intimate knowledge of forest animals and fish, which helped their efforts. Most tribes cultivated maize, beans, pumpkins, squash, gourds, sunflowers, and tobacco. Women did almost all the farm work except for clearing the land. When the first corn ripened in the summer,

Cherokee women harvesting and husking corn. Men are responsible for clearing the land, women for planting and harvesting (Eastern Woodlands Indians, Third Floor, Section 4).

Birchbark canoe, the most important means of travel along the waterways of the Eastern Woodlands (Third Floor, Section 4).

a ceremony of thanksgiving was held—the Green Corn Dance. This annual ritual, which marked the beginning of the new year, was a time of amnesty and forgiveness.

Although there were basic cultural similarities among the tribes of the Eastern Woodlands, the variety of their activities, depicted throughout the hall, illustrates the diversity of the many tribes. This cultural individuality was a source of tribal identity and pride for the early Indians and it underlies the same sentiments of their modern descendents.

The Eastern Woodlands Indians are now increasing in population after a period of decline and are participating fully in American and Canadian life. Although the bulk of Eastern Woodlands culture has vanished, the modern Indians still maintain some of their old customs, which serve as a source of identity and satisfaction and which are reminders of a proud and ancient heritage.

Other Exhibits

The Warburg Memorial Hall (First Floor, Section 3) shows the area where some Eastern Woodlands Indians lived, and the Hall of North American Forests (First Floor, Section 5) shows different kinds of woodlands in the east.

Mexico and Central America (Second Floor, Section 4)

The Hall of Mexico and Central America attempts to give the visitor an impression of the ancient civilizations that existed in these regions before their discovery by Europeans in the sixteenth century. Composed of various peoples such as the Olmec, the Maya, the Aztec, and others less well known, the civilizations endured for about 3000 years—from 1500 BC to 1520 AD. Legendary history, written down at the time of the conquest, reaches back to only about 1000 AD in central Mexico, so our knowledge of most of the history is based on archeology—the finding and excavation of ancient sites and the study of the objects that have been preserved.

The archeological history of Middle America, or Mesoamerica, as it is often called, is divided into three major periods: the Preclassic (1500 BC to 1 AD), the Classic (1 to 900 AD), and the Postclassic (900 to 1520 AD). The hall shows objects of all the cultures of these periods.

The Olmec of the Preclassic period, the beginning of civilization in Middle America, were noted for their very large sculptures and for their extraordinary jade carvings, such as a colossal stone head and a notable jade axe.

The Maya culture of the Classic period was one of the largest and most spectacular of the regional developments. In the hall are casts of large stone sculptures with elaborate carving and hieroglyphic inscriptions, objects from the great "city" of Teotihuacan located north of modern Mexico City, and stone sculpture, ceramic figurines, and vessels from central Vera Cruz.

The Toltec culture was in the early Postclassic period, followed by the Aztec, the dominant people until the capture by Cortes in 1520. The outstanding object in the hall, because of its size, is the copy of the so-called Aztec Calendar Stone, the best known of all Aztec objects.

Aztec stone of the sun, often called a calendar stone. The symbols relate to the sun, to which human sacrifices were offered (Mexico and Central America, Second Floor, Section 4).

Gold objects found in Peruvian tombs were once used as body decorations by rulers of the area (Mexico and Central America, Second Floor, Section 4).

Cultures of other regions of Mexico and Central America are represented in the hall. There are numerous fine examples of the ceramic sculpture of western Mexico and the stone carvings of the state of Guerrero. From Oaxaca, a distinctive cultural center that played an important role in the history of Middle America, are elaborate Zapotec funerary urns and a full-size facsimile of one of the painted tombs of Monte Alban. From the Huasteca, a region of northeastern Middle America, are delicate pottery figurines and a distinctive style in stone sculpture.

In an alcove just outside the entrance to the Hall of Mexico and Central America is a special exhibit of gold objects and jewelry made by the pre-Columbian peoples of the New World. This was the gold that so excited the European explorers and conquistadores of the sixteenth century. The objects here—from Peru, Ecuador, Colombia, Panama, Costa Rica, and Mexico—were all found in graves; almost no gold remains of the treasures carried back to Europe by the conquistadores.

Jade necklace from the Olmec culture. The longer pendants are in the form of jaguar claws (Mexico and Central America, Second Floor, Section 4).

Men of the Montaña (Second Floor, Section 3)

The area of tropical rain forest stretching from the foothills of the Andes eastward to the border of Brazil is known as the Montaña. This area of Peru and Ecuador is the home of a number of Indian tribes. Despite the fact that these tribes live very near the Andes, they are much more closely related to other Amazonian tribes than they are to the ancient Incas.

Within the Montaña there is an important environmental contrast between areas of rugged hilly terrain cut by narrow streams and low, flat areas lying along the larger rivers. Riverine tribes rely more heavily on fishing than on hunting, and are serious cultivators. They also have larger and more nearly permanent villages. On the other hand, tribes living in higher terrain away from the rivers do more hunting than fishing and are less careful cultivators. Moreover, their settlements are smaller and are moved more frequently.

The slash-and-burn method of cultivation, which is practiced throughout the Montaña, is depicted in the hall, along with the various crops grown by this means. Bows and arrows, blowguns, traps, harpoons, and other implements used to subsist are also shown.

Ceremonies, which are common among Montaña tribes, are generally accompanied by the consumption of large amounts of manioc or maize beer. Important stages of the life cycle are marked by ritual observances, and one exhibit case shows a young Conibo girl undergoing puberty initiation.

Warfare, once widespread in the Montaña, still occurs among remote tribes. In some raids, heads are taken, the best-known headhunters being the Jivaro of Ecuador. Not only do they cut off their enemies' heads, they also shrink them to about the size of a fist. Two shrunken heads are shown in the exhibit.

Decorative art in the Montaña is quite well developed among such tribes as the Shipibo, Conibo, and Piro of the Ucayali River. These tribes apply a series of complex geometric motifs to pottery and textiles, engrave them on artifacts of wood and bone, weave them into beadwork, and paint them on their faces and bodies.

Most tribes of the Montaña perforate their lips, noses, or ears for the insertion of a variety of ornaments. The Shipibo and Conibo seek to enhance their appearance further by artificially flattening their heads.

General Ecology

GENERAL ECOLOGY

Ecology is the study of the relationships of living things with one another and with their nonliving physical environment. Plants and animals of various kinds live almost everywhere, both in the water and on land. Their distribution, however, is neither uniform nor random. The ranges of green plants are controlled largely by climate and the chemical constitution of the soil, both of which are modified by the configuration of the landscape. The ranges of animal species depend directly or indirectly on the distribution of particular plants. Parasitic and saprophytic (scavenger) plants resemble animals in this respect.

The face of the earth is a vast patchwork of irregular and ill-defined areas, great and small, within which the physical environment is roughly uniform. Each area has developed its own characteristic assortment of green plants, which, in turn, support a characteristic variety of animals and dependent plants. Such a dynamic association of organisms constitutes a "biotic community." So strongly does the environment affect its inhabitants that communities half a world apart, though composed of different species, look very much alike, provided the climate, soil, and topography are similar.

The number of species in a biotic community reflects the climate and the variety of available "niches"—places to live and resources upon which to draw. The gentler the climate and the richer the assortment of niches offered, the more species of organisms that can simultaneously inhabit a region. No two species can fill exactly the same niche; sooner or later one will eliminate the other.

Polar bears are now threatened with extinction because they have been hunted from airplanes (Hall of Ocean Life, First Floor, Section 10).

Wolves have been killed off in many places by man because they are predators, resulting in an ecological imbalance among their former prey species (North American Mammals, First Floor, Section 13).

Coral reefs and tropical forests are the world's most complex biotic communities. Salt lakes and arctic tundras are among the simplest; resources are few, and physical conditions are so harsh that not many organisms can tolerate them. Individuals of adapted species, however, are often exceedingly numerous. Whether of few species or many, the "biomass," or total quantity of living substance in the community, is as great as the physical environment allows, and fluctuates with the seasons.

The interdependence of species within a community is nowhere better illustrated than by the "food web." Green plants are the primary source of food. In the presence of light they can build their own tissues out of nonliving materials—air, water, and minerals from the soil. Herbivorous animals feed on the plants. Inhabitants of dark environments such as caves and deep water are dependent on organic materials that reach them from lighted places. Carnivorous animals, both predators and parasites, eat the herbivores and one another. Scavengers and nongreen plants subsist on the wastes and dead bodies of other organisms. Ultimately, microbes in the soil complete the reduction of complex organic substances to simple compounds that green plants can use. Nothing is ever wasted. Recycling is not a human invention—it is the order of nature.

The number of individuals of any one species that a community can support is inversely proportional to their size. The territory of a fox is home to hundreds of mice and millions of insects. For every sulfur-bottom whale there are countless billions of krill; one whale daily harvests tens of thousands of them without appreciably affecting the total krill population.

The importance of organisms to one another is obvious; their importance in shaping the physical environment is easily overlooked. Oxygen, vital to animals, is the gift of green plants—a by-product of photosynthesis. Carbon dioxide, a by-product of respiration in both animals and plants, is suffocating to animals. During daylight green plants remove it from air and water and use it in the manufacture of sugar. A ground cover of vegetation protects soil from erosion and ensures the absorption of rainwater. Plants draw water out of the soil and transpire (exhale) it into the air, where it is eventually precipitated as rain or snow. The coral reefs and atolls of warm seas are built by generations of small polyps that extract their building materials from seawater. The limy shells of other marine creatures, accumulated on the ocean bed for eons, are incorporated into sedimentary rocks. Uplifted to the surface and weathered for millenia, they become constitutents of alkaline soils. A beaver dam creates a pond. Earthworms, ants, and other burrowing animals open the soil to air and water. Trails worn by the feet of animals become runoff channels, then gullies. Tree roots growing in crevices can split the rock and help to level mountains. The physical world would evolve slowly, even without living inhabitants, but plants and animals hasten the changes and influence their direction.

Of all animals, man has most greatly affected his environment. He is naturally adapted to a wide variety of biotic communities and is able to alter others to meet his requirements.When man was rare and modest in his demands the community functioned smoothly, supplying his needs and disposing of his rubbish without endangering other species. This no longer happens. Man is now so overwhelmingly abundant, so insatiably demanding, and so ingenious in exploiting the environment that most other organisms are incapable of surviving in his company. Man-made environmental changes are so great, so sudden, and so extensive that evolution cannot keep pace with them. Organisms whose accustomed environment has been disrupted must find other homes or die, and the number of possible places of retreat grows smaller each year. By the natural laws of community dynamics, if the human population continues to grow, the whole world must ultimately become a single ecological community inhabited almost solely by man and the few plants and animals best suited to supply human food. In the end, if man does not voluntarily curb his rate of reproduction, famine will control the population.

Our best hope of avoiding this bleak future lies in learning to accept ourselves as members of an ecological community in which each participating species and every aspect of the physical environment plays a necessary role. We must take no more out of the environment than the community can replace and put no more in than the community can absorb. Unfortunately, we do not yet have sufficient knowledge of any of the communities in which we live to use them optimally, with maximum benefit to ourselves and minimum disadvantage to our fellow organisms. The work of ecologists in gaining that knowledge is

Walrus on an ice floe in the Arctic. The large tusks are used to plow up the ocean floor in search of mollusks and other invertebrates (Hall of Ocean Life, First Floor, Section 10).

of the most immediate and practical importance, not only for saving all the species that still share the planet with us, but also for preserving our own species from catastrophe.

There is no Department of Ecology at the Museum, but members of many of the departments are involved with research in varied ecological fields.

Felix M. Warburg Memorial Hall (First Floor, Section 3)

The Warburg Hall shows a multitude of biotic communities in one area—Pine Plains, a typical rural area in Dutchess County, ninety miles north of New York City. Here is shown something of the geological history of the region and of its natural biotic communities, as well as the story of man's impact on the land—his establishment of artificial communities, their eventual abandonment, the development of new natural communities on the exhausted soil, and their gradual reversion to the original forest. Examining this one small area in detail reveals natural laws that govern all the biotic communities of the world.

Hall of North American Forests (First Floor, Section 5)

In the Hall of North American Forests one type of biotic community—the forest—is analyzed and dissected. The variety of this type of community, from northern Mexico to central Canada, is seen in eleven habitat groups. Many aspects of the internal workings of the community and of external influences upon it, including man's use of the forest, are shown in a number of smaller exhibits.

Hall of Ocean Life (First Floor, Section 10)

In the Hall of Ocean Life are several habitat groups of all sorts of animals living in marine environments. These include invertebrates, fishes, birds, reptiles, and mammals, all of which depend on each other.

Various kinds of mammals have adapted to life in the seas in different ways. Some, such as the whales, dolphins, and manatees, are so highly specialized that they cannot exist on land at all, while others spend most of their time in water but, like seals and sea lions, return to the shores to give birth. Still others, like the polar bear, are equally at home on land or sea.

The ninety-four-foot replica of a blue whale that dominates the center of the hall represents not only the largest animal that has ever lived on earth, but also the plight of many marine mammals. Excessively killed for oil and other products, blue whales are now gravely endangered and threatened with extinction. Some of the other mammals shown on the lower floor are also considered endangered.

Polar bears are hunted for trophies and are much diminished in numbers,

Mole burrows beneath tulips during the spring. All of the plants and animals shown are necessary to the ecosystem of the region (Warburg Memorial, First Floor, Section 3).

while sea otters and elephant seals are now recovering from near extinction in the recent past. Some kinds of dolphins are being killed in huge numbers as an accident of commercial tuna fishing, while new threats loom as seals, sea lions, sea otters, and polar bears are found to accumulate the toxic chemicals man has dumped into the seas.

ENDANGERED SPECIES

One hears all sorts of talk these days about endangered species, and the definition of endangerment has become critical to the laws that are being passed and even to individuals in determining what products they might buy. Industries involved in utilizing wild animals often claim that the species they use are not endangered. Biologists claim otherwise. Who is right? What do they mean by endangered?

To the biologist an endangered species is one that will become extinct if the trend of utilization is continued. All too often, endangered to an industrialist is only when an animal is in such short supply that he cannot get sufficient quantities of it to maintain production. Neither the biologist nor the manufacturer may know the actual numbers of the animals remaining. Counting the animals in the wild is a difficult problem, to say the least. Who is right? *When* is a species endangered?

A species is endangered when, as in the case of the cheetah, it has disappeared from areas it once formerly occurred. In India, where cheetahs once lived, they are no longer to be found. A species is endangered when, as in the case of the Antarctic blue whales, the number of animals required to maintain the industry is greater than the existing stocks. The recent whaling quotas are more than five times the 2000 or less Antarctic blue whales remaining. A species is endangered when, as in the case of the vicuña of the Andes, its numbers diminish markedly in a short time. If the United States imports the same amount of vicuña wool this year as it did in 1965, the species will be extinct. There are fewer than 5000 of these animals remaining; twenty years ago there were almost half a million. A species is endangered when, as in the case of the red wolf of the United States, it is persistently and relentlessly persecuted because it sometimes attacks man's livestock. Or when, as with the polar bear, its hunting for trophies is conducted in such a manner as to permit no individual to escape.

All species are endangered when their environment is destroyed, their sources of food eliminated, their sites of shelter destroyed, their drinking water polluted, their air, food, and water poisoned in subtle ways that affect their ability to reproduce themselves.

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On the Cover

Detail from a shaman's mask in the Hall of Northwest Coast Indians. The mask is made of wood, plaits of human hair, eagle feathers, swansdown, bluejay wings, and the fur of the brown bear. The mask was used by a Tlingit shaman in religious and curing ceremonies in the nineteenth century.