Working the Earth!

The Swedish Museum of Natural History is a major research institute that combines a venerable tradition with modern working methods. Our collections constitute an amazing archive of the natural world and our research laboratories are world-class. The research staff at the museum collaborate with colleagues all over the world, and we receive several hundred guest researchers every year.

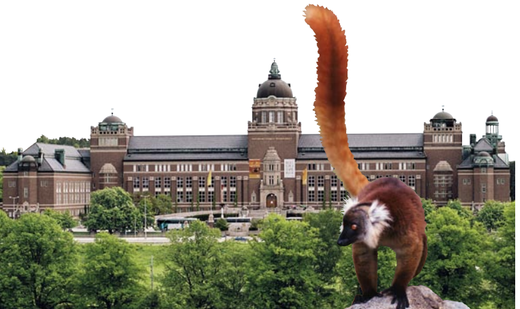
This brochure describes the research work, and the work carried out in the collections, at the Swedish Museum of Natural History. Visitors to our museum, and all other natural history museums, see only the tip of an iceberg. The exhibitions, teaching activities, public programmes and – at the Swedish Museum of Natural History – Cosmonova, are the parts that the visitor sees. All of these parts have common base in our research work and the work we do in the collections.

It is our goal to awaken interest in young people for the natural world and natural sciences, the environment, conservation and biological diversity. The museum, together with Cosmonova, was visited by nearly 800,000 people in 2005. Half of these were children and young people who often visit the museum as part of their education. Meetings with our teaching staff are a key part of these visits.

Researchers from the museum give university courses and supervise research students. We host guest researchers from all over the world to carry out post-doctoral research. The museum has been granted the status of "Major Research Infrastructure" by the EU, and it is a member of a network of major natural history museums in Europe that together are carrying out the SYNTHESYS project, funded by the EU.

The concept of "accessibility" has acquired a new dimension in recent years, one that includes access to the internet. The website of the museum contains a great deal of information about our research and collections. We have established a special service, known as "Duty Biologist", on the website in order to be able to answer these questions, both simple and complex, and we also have the possibility of answering questions about geology. People ask the museum a multitude of questions, both by telephone and over the internet.

More information about the fascinating and important work that our researchers and our curators are carrying out – with roots in the past and our eyes firmly fixed on the future – can be found in a more detailed brochure that the museum has published describing our research work and the work with the collections.



Our Collections are our Core

Nearly 300 years of collection have resulted in more than 9 million specimens in the museum's collections: plants, animals, fossils and minerals. Jonas Alströmer, a member of Royal Swedish Academy of Sciences who is most famous for introducing the potato into Sweden, donated a fungus at the first meeting of the Academy in 1739. This became the first item in the collections of what would later become the museum.

The museum's scientific collections of phanerogamae – seed-bearing plants – contains approximately 3 million specimens. Parts of Carl Linnaeus' collections are held here. The collections of cryptogamae – plants that lack seeds – contains approximately 1.5 million specimens: of ferns, bryophytes, fungi, lichens and algae.

The collections of vertebrate zoology – animals with backbones – contain 300,000 specimens and consist of fish, birds, mammals, amphibians and reptiles. The collections of invertebrates consist of approximately 550,000 specimens of animals that lack backbones, such as sponges, jellyfish, corals, many types of worm, mussels, octopi, crustaceans and sea urchins. The entomological collections contain approximately 2.5 million specimens.

The collection of insects includes flies, wasps, beetles, butterflies, grasshoppers and true bugs. The entomological collections also covers other animal groups such as spiders, scorpions, centipedes and millipedes.

The paleozoological collections at the museum comprise 860,000 specimens from fossilised vertebrates and invertebrates. The collections include fossils from the whole history of animals, more than 500 million years into the past. The paleobotanical collections include 175,000 specimens of fossilised plants, of which the fossils from the polar regions and from China are particularly valuable. The collection of minerals consists of approximately 150,000 catalogued specimens, approximately half of them from Swedish locations.

The Environmental Specimen Bank contains 270,000 samples primarily from fish, birds and mammals collected after 1964, and it forms the basis of the museum's research and monitoring of environmental contaminants.

The preservation group at the museum works with preserving and preventative care of the collections. We also lead Swedish research and collaboration into protection of museum collections from pests, work that is carried out under the auspices of the national pest control group, PRE-MAL.

Examples of hoverflies in an insect box from the entomological collection. Photo: Staffan Waerndt

Collaboration in Four Fundamental Research Themes

All activities at the Swedish Museum of Natural History concern various aspects of the development of the Earth, the life it hosts, and aspects of the interaction between humans and the world around us. Our research is an important part of our activities and covers a wide spectrum that includes botany, zoology, palaeontology, geology and ecotoxicology.

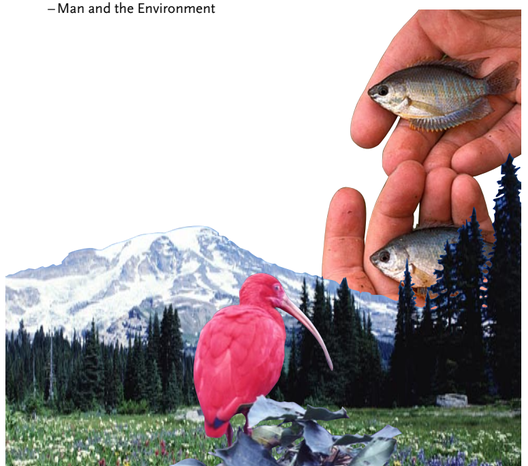
The research is financed largely by external funds. The principal sources of finance are the Swedish Research Council (Vetenskapsrådet), the Swedish Research Council for Environment, Agricultural Sciences and Spatial Planning (Formas), the Swedish Species Information Centre, and the EU. We also receive many small and individual grants from a variety of other sources.

Our research activities are focused into four themes:
- The Changing Earth
- Ecosystems and Species History
- The Diversity of Life
- Man and the Environment

These themes allow us to combine our specialist knowledge in different fields and in this way obtain increased understanding of the processes that have influenced, and continue to influence, the development and diversity of the Earth and life on it. The clearly defined research themes also make it easier for us to make our research available to a wider public.

The museum conducts other knowledge-based activities in relevant fields, in addition to research. An example is the administration of the Swedish programme for ringing birds, and the publication of daily pollen forecasts during the pollen season. All of these activities have in common the application of our expertise as a benefit to society in the form of concrete measures taken and information distributed.

The following pages present our four research themes and other activities related to research.



The Development of the Earth and Life on It

The history of the Earth and the history of life have been intimately woven together for billions of years. Researchers at the Swedish Museum of Natural History working in the research theme "The Changing Earth" investigate the development of the Earth's crust, its oceans, and its atmosphere, and they also investigate how changing geological conditions have affected the development of life on our planet and, conversely, how the development of the Earth has been affected by biological factors.

Time – the fourth dimension – is a central concept in geological research. It is important to be able to date events and processes in the history of the Earth, in order to understand geological development. This is achieved by measuring the amounts of radioactive elements and their daughters naturally found in rocks, which thus function as geological clocks. The Swedish Museum of Natural History has modern laboratories for such measurements.

Dating the rocks of the Earth's crust enables us to understand how the continents have been built up over the ages, when continental drift started, when water in liquid form started to appear, and when the conditions on earth became suitable for life.

We investigate how boron, a trace element which affects the crystallisation temperature of liquid rock material and the viscosity of lavas, occurs in ordinary minerals. Iron and manganese can have different valences in the bedrock, depending on the availability of oxygen when the rocks formed. We develop new analytical methods to study such variations.

We are studying the isotope composition of oxygen to investigate how the atmosphere and biosphere of the Earth has developed through time. We can follow the development of life through the deposition of sedimentary layers. We are also studying the reasons for the mass extinctions that have taken place several times during the development of the Earth.

In addition to the water that is present today in the hydrosphere, large quantities of water are bound into the structures of minerals, including minerals deep in the Earth's mantle. There is probably more water bound in the mantel mantle than the volume of water in the Earth's oceans. We are studying the chemistry of minerals and determining how the water is bound in the minerals, and the effect that this may have on processes in the mantle.

Research in natural history is based on observation and collecting samples from the natural world. Researchers from the Swedish Museum of Natural History are active throughout the world, here on a field trip in Iceland. Photo: Gerwin Gruber

Large-Scale Biological Processes in Time and Space

The ecosystems that we see today are the result of an evolutionary history that extends millions of years into the past, driven by the interaction between geological and biological processes. The historical development of processes and patterns in ecosystems is being studied at the Swedish Museum of Natural History in the research theme "Ecosystems and Species History".

The sensitivity of an ecosystem for global changes depends not only on modern processes, but also on historical processes. The genetic composition of an ecosystem determines its ability to respond to changes it experiences today. This composition is the result of the interaction between geological and biological processes over long periods.

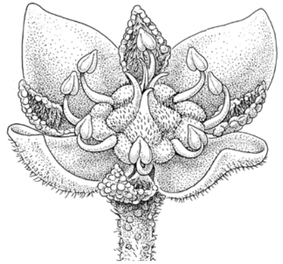
The flora of the northern hemisphere during the early Tertiary period, 65–25 million years ago, was generally subtropical to warm temperate, and it was significantly more homogeneous than it is today. The flora, however, developed as a result of global changes to the same kind of ecosystems that we see today, in the form of Mediterranean systems and temperate systems.

By studying the species history of various families of tree, we can increase our knowledge of this process of change. We use a combination of DNA methods and morphological properties to determine the relationships between different species.

A second line is the study of the ways in which complete ecosystems change with time.

A good example of this is our research into the origin of grass ecosystems. The study of fossil phytoliths, small grains of opal that are extruded by some plants and that are characteristic for different types of grass, allow us to document the development from forests to open grasslands. Previous studies of the origin of grasslands have been based on the origin of herbivores specialised to eat grass. Our new research suggests that these herbivores actually evolved millions of years after the grasslands had become a dominating ecosystem.

We are also investigating how the small two-legged ancestors of humans evolved from being an important prey for predators to a significant competitor to these predators. This phase in the development of humans was, and still is, highly significant for the composition of the ecosystems.



A reconstruction of Platydiscus peltatus, a fossil flower from 80 million years before the present, from Cretaceous deposits in Skåne. The flower is 3 mm across. The plant family Cunoniaceae no longer exists in Europe. Illustration: Pollyanna von Knorring

Global Survey of the Diversity of Life

It is estimated that there are 5–10 million species of plants, fungi and animals on Earth, and most of these have not been described. All known species have more or less, to varying extents, important roles to play in the ecosystems, and we can assume that many of the species that are unknown today are beneficial for humans. Around 30 researchers at the Swedish Museum of Natural History are directly involved in research in the theme "The Diversity of Life", and the work they do is both stimulating and important.

One important part of the work is the collection of new material. Most of the Earth's biological diversity is found in tropical regions, and it can take many years to process the material collected from a journey to these regions. One important result of this work, is that researchers at the museum identify approximately 50 new species from all over the world, every year.

Researchers from the museum are surveying diversity in exotic far-away places, as well as in our own neighbourhood. We are participating, for example, in a flora that will cover Malaysia, Indonesia, the Philippines and New Guinea when it is complete. We have also inventoried, among other groups, flowering plants in Småland, and published a flora based on this inventory.

The museum is responsible in Sweden for the Swedish Malaise Traps project, in which several hundred million examples, particularly insects from poorly known insect groups such as Hymenoptera and Diptera, were collected between the summer of 2003 and the winter of 2005–2006. The material that has been collected will take decades to analyse and we are expecting to find many new species.

Our researchers are also working to clarify how species of plants, fungi and animals are related to each other. Research in this field is now significantly aided by modern methods in molecular biology and modern computer-based methods of analysis. We are now able to produce and analyse enormous quantities of data far more quickly than just a few decades ago. One result of this research is a radical reassessment of our ideas concerning the development and relationships between different groups of organisms. Our researchers have found, for example, several types of birds with markedly different appearances being closely related with each other, in contrast to previous understanding.

The smooth dreamer, Chaenophryne draco, a black ball with knife-sharp teeth, is an example of deep-water fauna that is difficult to study in the wild, and remains relatively unknown. Photo: Sven Kullander

Research to Promote a Natural Environment and Sustainable Development

The Swedish Museum of Natural History carries out both applied research into the natural world and the environment, and fundamental ecological research in the theme "Man and the Environment". Examples of activities within the theme are national environmental monitoring, the monitoring of migration patterns of birds, and investigation into allergens. Our research skills and our knowledge of species contribute to a better understanding of the world around us and thus improve the possibilities of attaining sustainable development.

We carry out monitoring programmes of environmental contaminants, both in the terrestrial and the aquatic environment. These studies over time are the longest-running of their type. They include, for example, pike from Storvindeln and guillemot eggs from Stora Karlsö, which have been collected for the analysis of environmental contaminants every year since 1967. Chlorinated organic compounds that are environmental toxins, such as PCB, DDT and dioxins, are monitored, as are other substances such as brominated flame retardants and metals.

The reports of harm to the seals of the Baltic Sea are the most serious reports in the world about damage to mammals from environmental contaminants. We are carrying out research to document the state of health and the incidence of disease, and the reasons behind these.

We are also responsible for monitoring the population of seals in Swedish waters. The sea eagle and the otter are two other species that have been severely affected by environmental toxins, are we are studying these species intensively.

We are conducting a project around the fresh-water mussel. Most of the Swedish populations are composed solely of older mussels and this means that they will eventually become extinct unless renewal is achieved.

Around two-thirds of the species of birds that nest in Sweden leave the country for some part of the year. The migration patterns of birds are being continuously monitored through the Swedish programme of ringing birds. Another project is studying how migratory birds are being affected by the recent relative mildness of the climate. Bird migration is an important factor in association with the spread of certain diseases, such as avian flu, and tick-borne diseases.

Allergens in, for example, plant pollen cause considerable problems for people who are sensitive to them. We are participating in a research project, in association with our work in forecasting pollen levels, in which we are studying the size distribution of the allergens, and their principal pathways to reach indoor air.

Visiting the sea eagle. Monitoring of marine top consumers involves checking the result of nesting, taking samples of feathers, and ring-labelling the young birds. Photo: Kurt Elmquist

Serving Society

Our staff are involved in many activities and collaborative efforts in addition to the research projects included in the four research themes. All of our activities contribute to increasing and spreading knowledge about the development and diversity of the earth and life on it, and the relationship between humans and the natural world.

Allergy is a major problem for many people, and it is becoming more severe in the western world. The Swedish Museum of Natural History produces pollen forecasts that help people with allergy to plan their everyday life and take their medicine effectively.

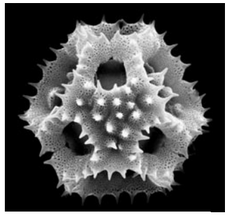
Ringing wild birds is controlled by the Swedish Museum of Natural History. Approximately 300,000 birds are equipped with addressed and numbered rings each year. Nearly 4,000 recoveries of ringed birds are reported to us each year.

A number of selected mammal and bird species have been designated as "State Game", and if they are found dead, they must be handed over to the police to be sent onwards to the Swedish Museum of Natural History.

The Nordic NORDSIM laboratory for geological research is comprises an ion microprobe, with which we can measure the composition of isotopes in selected areas of a specimen, down to a few micrometers in size. Such analyses allow researchers to understand and explain very complex geological processes.

The Laboratory of Molecular Systematics works with analysing the genetic material of various organisms using modern DNA technology. These methods have revolutionised our view of family relationships and evolution. DNA can often be recovered from material that was collected more than 100 years ago, and this means that our collections are invaluable resources for these studies.

The Swedish Museum of Natural History is host for the Swedish node of GBIF (the Global Biodiversity Information Facility), an international project whose task is to make information about the biological diversity of the Earth available at one common internet portal. FishBase is a further international project, which is built up around databases with information about fish from around the world. The museum's own databases contained over 1 million records in 2006, and they are growing all the time.



Scanning electron microscopy image of dandelion pollen. This grain is 0.03 millimetres in diameter. Source: Palynologic laboratory, the Swedish Museum of Natural History

Naturhistoriska riksmuseet

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Research and Collections at the Swedish Museum of Natural History

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