SENCKENBERG

world of biodiversity

Research for the Future

Contents

Cover photo: This aerial photograph shows a river in Alaska where bears hunt for salmon. To safeguard ecosystems like this for the future, they must be properly understood. In the quest to protect natural habitats, Senckenberg carries out research all over the world.

"Research and education for a sustainable future"

Volker Mosbrugger

Dietmar Schmid

Dear Reader,

The Senckenberg Gesellschaft für Naturforschung (hereafter Senckenberg or SGN) has compiled this publication – Senckenberg World of Biodiversity – to tell you who were are, what we do, and how our research benefits society. Senckenberg investigates the interrelationships between the various elements of nature and communicates its findings in many ways. As many other institutions in Germany, Europe and around the world do much the same thing, this might not seem very impressive at first sight.

What makes Senckenberg unique is its research network spanning ten different locations throughout Germany, its vast specimen collections, and its highly specialised, diverse expertise ranging from marine organisms and mountain ecosystems to dating the oldest rock formations and modelling the climate. This broad spectrum fosters a better understanding of the human-Earth system, which in turn leads to better management of our planet's precious resources. As scientists, this is not just something we want to do – we feel it is something we must do.

This is why we think it important to showcase our research work at Germany's state-of-the-art nature museums in Frankfurt, Görlitz and Dresden. To inform, educate and advise the general public, we use multimedia channels such as print publications, the internet, and audio and video presentations – all on both a popular science and academic basis. The success of this approach shines through not just in the interest shown by the 600,000 visitors we receive each year, but in the fact that thanks to our social engagement, Senckenberg is an integral part of society.

Turn the page and dive straight into the Senckenberg World of Biodiversity. Explore the fascination of the bioscience and geoscience landscape – and the fascination of Senckenberg.

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Research at Senckenberg

Digging deep: Senckenberg researchers venture into the remotest regions in search of answers to questions on the geological and biological evolution on Earth. Here they tackle the permafrost in Jakutia, Russia.

To fully understand something, you have to look at it in detail. Rainforest research reveals key information about biodiversity on Earth (right). An ant approaches the entrance to its lair in a hollow acacia thorn (left).

Biological Diversity

In the depths of the ocean, at the top of a mountain or in the middle of the rainforest: Senckenberg works on research projects all around the globe. And it does so with an ambitious goal: to identify, record and preserve the diversity of life on Earth – Earth's biodiversity. But before the ecosystems can be preserved and life made better for future generations, nature and its complex chain of relationships must be truly understood. Although an estimated 100 million species inhabit the Earth, less than two million have been identified to date. And over 100 species become extinct every day. Species loss and other global impacts caused by human activity increase apace.

It is thus all the more important for research to keep in step with nature. To do so, Senckenberg research takes in three core areas:

- Studying organismic biodiversity
- Investigating ecosystems
- Researching the entire life-Earth system

So Senckenberg's 'world of biodiversity' slogan certainly fits the bill when its highly qualified 300 plus scientists, 150 doctoral students and 50 undergraduates design, implement and evaluate in-depth studies on the Earth's biodiversity.

At six institutes spread over ten locations in Germany, the latest technology is used in research performed across the various disciplines of bioscience and geoscience. In performing this work, researchers collaborate with other renowned research institutes to work on projects all over the world.

The evolution and development of fauna is a core research subject. This includes studying Germany's current wolf population (left), and analysing the famous Messel Pit fossils (right).

While the German Centre for Marine Biodiversity Research (DZMB) drives systematic identification of what are still largely unknown marine life forms, other institutes focus intensively on terrestrial flora and fauna. These include molecular genetic studies of Germany's living species, such as the wolf and the lynx, and the investigation of domestic soil microorganisms. Research also covers distant ecosystems in Africa, South-East Asia and Latin America.

Reviewing the past is key to understanding the present and the future. Senckenberg investigates the ecological processes that have shaped the Earth over millions of years, and uses palaeontology – the study of fossils through the ages – to learn lessons for today's world. Its research conducted at the UNESCO World Heritage site at Messel Pit has revealed a treasure trove of extraordinary finds like 'Ida', a very early primate and distant relative of modern man.

Learning from the past is also the approach taken by researchers at the LOEWE Biodiversity and Climate Change Research Centre (BiK-F), a joint project between Senckenberg, the Johann Wolfgang Goethe University of Frankfurt, the Institute for Social-Ecological Research, and other partners to better understand the interaction between the living world and climate change. This diversity in scientific engagement is what makes Senckenberg research so unique.

Senckenberg's Research Collections: A veritable Who's Who of life

In vast archives, Senckenberg's research collections have grown over the past 200 years and longer. With over 35 million specimen plants, animals and rocks, it is one of the few collections of its size in the world. The roots of the Senckenberg Natural History Collections of Dresden go back as far as the 16th century, which makes them the oldest natural science collections in the world.

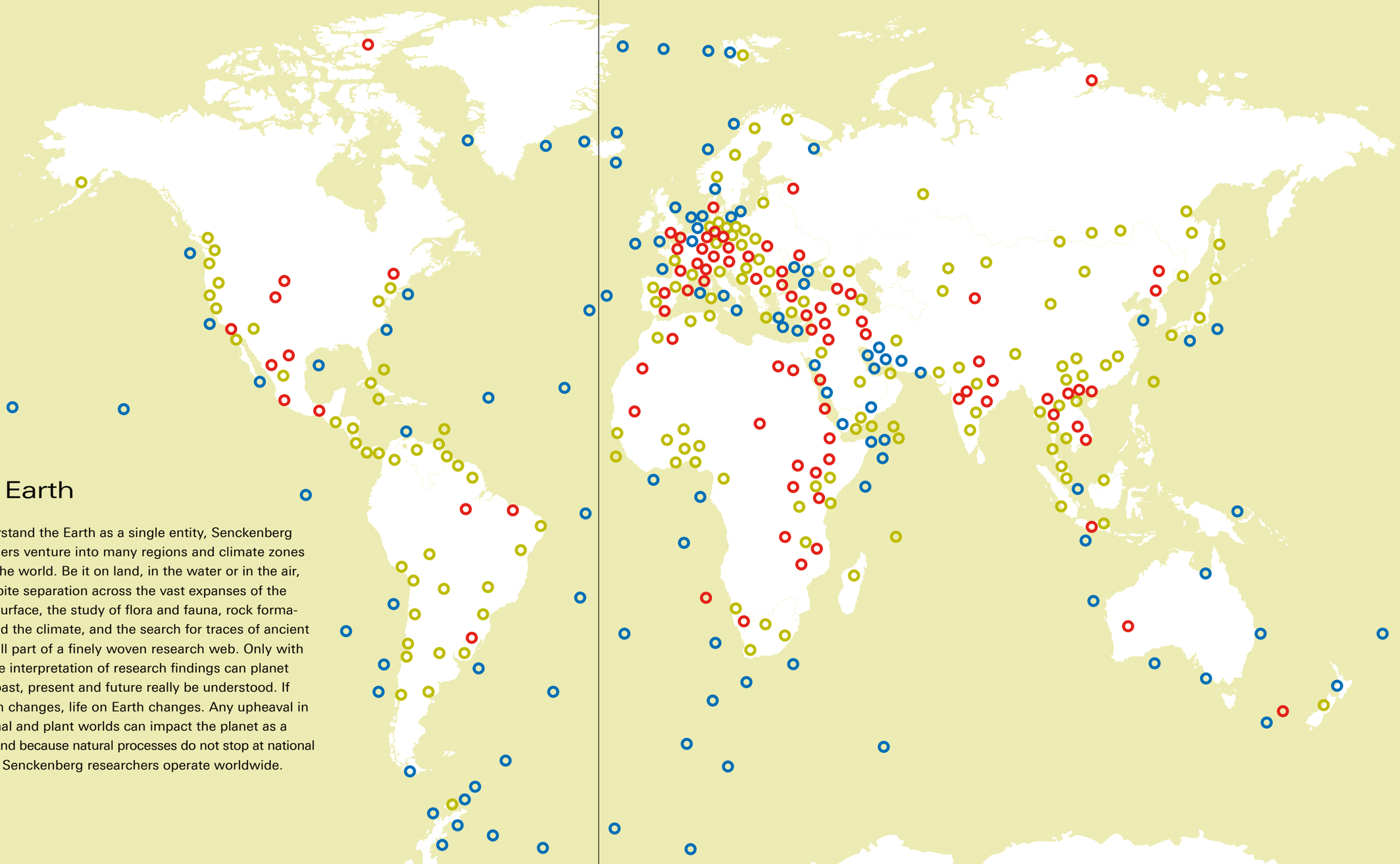
A hub of knowledge: In the subterranean archives in Frankfurt, specimens from all over world are stored for research purposes. There are literally millions of sample specimens.

Senckenberg's collections shed light on vital aspects of species evolution and the dynamics of change in the biosphere. Specially trained staff ensure that the collections are kept up to date. They digitise the associated research data and develop new methods of analysis. The specimens and the knowledge that goes with them provide the vital groundwork for numerous research projects. Focusing on specific research topics, the various institutes and research stations around the country take an interdisciplinary approach as they unfold the mysteries of natural science.

The Senckenberg headquarter and control centre for Senckenberg's extensive research network is located in Frankfurt am Main right in the centre of Germany and right at the heart of Europe. It was on this site that the "Senckenbergische Naturforschende Gesellschaft" (Senckenberg Nature Research Society) was founded back in 1817.

Senckenberg Around the Globe

- *Continental Systems: Analysis of terrestrial and limnic ecosystems*
- *Fossil Systems: Geological research and the study of ancient ecosystems*
- *Marine Systems: Projects to investigate ocean habitats*

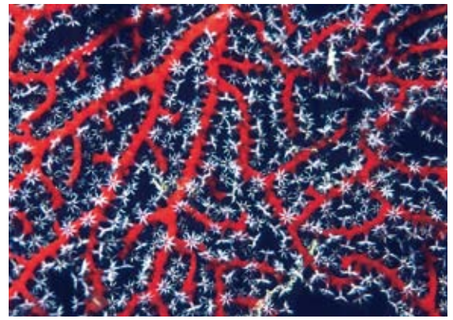


The Earth

To understand the Earth as a single entity, Senckenberg researchers venture into many regions and climate zones around the world. Be it on land, in the water or in the air, and despite separation across the vast expanses of the Earth's surface, the study of flora and fauna, rock formations, and the climate, and the search for traces of ancient life are all part of a finely woven research web. Only with collective interpretation of research findings can planet Earth's past, present and future really be understood. If the Earth changes, life on Earth changes. Any upheaval in the animal and plant worlds can impact the planet as a whole. And because natural processes do not stop at national borders, Senckenberg researchers operate worldwide.

The Circle of Life: Covering almost three quarters of the Earth's surface, the oceans are home to myriad inter-connected lifeforms. Senckenberg scientists take a deep dive into marine biodiversity.

Organisms



The seas are alive. Anoplogaster cornuta (left) and gorgonion coral encrusted with white polyps (right) – nature's underwater theatre casts its colourful characters across the oceans deep.

Sea Search. Research.

Senckenberg gets to the bottom of things, not least in marine science. While the oceans harbour rich species diversity, much of it remains a mystery. Therein lies the challenge: although the oceans cover around three quarters of the Earth's surface, research has identified far more land-based lifeforms than marine plants and animals.

This is why Senckenberg scientists were quick to take a leading role in the Census of the Diversity of Abyssal Marine Life (CeDAMar) project, an international research programme in which benthic organisms were surveyed and studied at depths of several thousand metres. Hundreds of new species were discovered. By systematically classifying, documenting and archiving the census samples, Senckenberg was instrumental not just in fostering a better understanding of our blue planet and the evolution of life, but in establishing a vital knowledge base that is invaluable, both in protecting biodiversity and in securing human survival.

Habitats

In the highlands of Tibet, plants, animals and people face extreme conditions. How this ecosystem works at an altitude of several thousand metres is the focus of an international research project in which Senckenberg is a major player.

Ecosystems Top Senckenberg's Research Agenda

As an integral component of nature, human beings have a radical effect on the natural environment, impacting not just on natural habitats but on entire ecosystems. Their influences reach to even the remotest parts of the planet. One particularly sensitive indicator – both of natural change and of that caused by people – is found in the sprawling Tibetan highlands and the Himalayas. Like the Arctic and Antarctic, Tibet provides a perfect setting for the study of environmental change.

With Senckenberg researchers on the team, the TIP project (The Tibetan Plateau: Formation – Climate – Ecosystems) gives the inside story on habitat evolution. Be it geological developments over the past million years, climate change in the last millennium, or the impact of human activity today, different layers of the Earth and of natural history are investigated and interlinked by experts from various disciplines. This research is vital because knowledge on how today's ecosystems came about reveals how they will evolve in the future, independent of human influence.

The System Earth – Humans

Complex climate history: Just as the climate influences life on Earth, so life affects the climate. This interaction could impact significantly on human life in the future.

Checking Out Climate Change

Climatic influences: The climate affects both the animal and the plant worlds, and these in turn affect the climate. This happens on a global scale: when huge areas of forest are destroyed in the Amazon, in Central Africa or in South-East Asia, it has an altering effect on the climate across the globe. Diversity in flora and fauna thus writes climate history – with far-reaching effects for humans.

Deciphering these complex interrelationships is the focus of research performed at the Frankfurt-based Biodiversity and Climate Research Centre (BiK-F). Senckenberg is a major player in that research, looking at events in earlier phases of the Earth's history and at the situation today. BiK-F researchers have shown that the evolution of the Sahara desert some 10 million years ago triggered climatic change on a global scale. Using models and scenarios, they are able to estimate how the diverse forms of life on Earth might be influenced by climate change in future. People play a central role: their impact on biodiversity is instrumental in climate change. Studies performed by BiK-F thus lead to recommendations on how to manage the living environment and foster an ecosystem-friendly climate.

Senckenberg Museums

Dinosaurs et al. Senckenberg's Natural History Museum in Frankfurt is hugely popular, attracting around 400,000 visitors of all ages each year.

Be it Europe's biggest bird display (left) or the Anaconda Swallows Capybara show (right): The exhibition depicts the many facets of nature. Several exhibits have achieved fame way beyond Frankfurt's boundaries.

Showcase for Life

Senckenberg has used dinosaurs, prehistoric man and giant whales as teaching aids for the best part of 200 years. It communicates both its work and its findings by combining rare and often spectacular exhibits with state-of-the art educational concepts. Each year, some 400,000 visitors old and young from all over the world visit the Senckenberg Natural History Museum in Frankfurt – or what millions have come to call just The Senckenberg in reverence to its status. For generations of people in Frankfurt and elsewhere, the museum with the neo-Baroque façade has become something of an institution.

Classical as the architecture might be, the methods of knowledge transfer are bang up to date: in getting its message across, the museum applies the very latest in educational research findings. Traditional information boards using a mix of text and pictures are augmented with modern media resources such as computers, a cinema showing documentaries, and audio tours. And with target group-focused tours, events tailored to specific audiences, and a varied programme of other offerings big and small, the museum's educational experts reach a very broad public.

At the Senckenberg Natural Science Museum in Görlitz, visitors can take a close-up look at the world of animals and plants (left). The impressive piece of quartz with cassiterite crystals stems from the centuries old natural history collections in Dresden.

At present, Senckenberg's Natural History Museum in Frankfurt is one of Europe's biggest natural science museums. Its 6,000 m² of exhibition space houses several thousand exhibits. From tropical butterflies to the fin whale, from fossilised plants to meteorites from outer space, from the water cycle to human evolution: exhibits and topics like these are used to illustrate biodiversity and the Earth system.

For visitors to the museum, one of the most impressive exhibits is the dinosaur room – although this gets close competition from the 'gripping' display of a giant anaconda swallowing a capybara. Plans are now underway for major extensions to the exhibition area.

Evolution, diverse life forms, and the history of the Earth are all focal points in the other museums in the Senckenberg network.

At the Senckenberg Museum of Natural History in Görlitz, visitors are treated to a fascinating insight into the living world in the soil under foot. The natural history collections in Dresden use rotating exhibitions on current topics concerning the living environment, geology and mineralogy. In this way, the Senckenberg Gesellschaft für Naturforschung (SGN) uses a wide variety of permanent exhibitions and regularly changing special exhibits to present the full scope of the living world and the human-Earth system.

Special exhibitions like the "Safari to Early Humans" show take visitors on fascinating journeys through time and space. Using modern educational resources, they help keep people in the know about nature.

The Senckenberg Research Society

A bronze bust of Johann Christian Senckenberg, after whom the society is named, graces the entrance to SGN's head-quarters.

Age-old Democratic Ideals and Modern Technology

The history of nature: conducting research and communicating bioscience and geoscience findings have a long tradition at Senckenberg. Since its foundation in 1817, SGN has stayed true to the principles set down in its articles, which among other things state that "it is the task of SGN to conduct nature research and to make its findings accessible to the general public by means of publications, education and natural history museums" (Section 2 (2)). Today, its research focus lies in biodiversity, evolution and climate change. SGN's official education mandate comes from the International Council of Museums (ICOM), which it fulfils to the highest possible standards in the quality and quantity of its presentations and museum-based education.

Behind the Neo-baroque façade of the Senckenberg Natural History Museum (left) lies a world of active modern research. Visitors to the museum can choose from a variety of events to learn all about SGN's research results (right).

Since 1954, SGN has been a member of the *Königssteiner Staatsabkommen*, an agreement between the German states on the provision of funding for research, from which the Leibniz Association of research institutes evolved. Along with the Helmholtz Society, the Max Planck Society and the Fraunhofer Society, the Leibniz Association is one of the largest networks of research institutes in Germany. It addresses scientific issues of social importance. Senckenberg receives the major part of its funding from the German government and the German states. And as a civil society, SGN follows the principles of democracy in its work. For a small annual contribution, anyone who is interested in natural science can become a member. Members receive free entrance to museums, a copy of the bimonthly popular–science journal *Natur Forschung Museum*, and other benefits. The General Assembly elects the Administrative Board *(Verwaltungsrat)*, which comprises ordinary members, funders from national and state governments, and representatives of the City of Frankfurt council. In turn, the Board appoints both the Board of Directors as an operational management body, and the honorary Presiding Board *(Präsidium)*.

SGN boasts upwards of 4,600 members and employs around 1,000 people. Its research team has access to some of the most modern methods and high-tech equipment available today. These include tomography, x-ray analysis, electron miscroscopy, 3D morphometry, DNA laboratories and research ships. Apart from the museum exhibitions, numerous other activities conducted by the public relations office and the marketing department, and 17 serial publications target a broad audience. In both research and education, Senckenberg's 200-year success story marches on.

Senckenberg at a Glance

Whether investigating prehistoric humans in Africa or working on the Polar Star expedition in the Antarctic, Senckenberg research connects people across the world.

Combined expertise: SGN's archives house millions of specimens (left). Senckenberg conferences serve as meeting opportunities for researchers from all over the world (right).

Senckenberg Gesellschaft für Naturforschung (SGN): Facts and Figures

Senckenberg – world of biodiversity: A slogan that fronts a whole universe of natural science. SGN is one of the few institutions, national and international, to operate such a comprehensive education and research programme with the primary aim of researching, protecting and safeguarding biodiversity, and thus life on Earth. Some of the most important fact about Senckenberg at a glance:

- Active research around the globe
- Member of the Leibniz Society (WGL) – a network of research institutes whose work focuses on topics of social importance.
- Management of the Biodiversity and Climate Research Centre (BiK-F) run in conjunction with the Johann Wolfgang Goethe University of Frankfurt and other sectoral partners.
- The operation of a federal structure made up of six Senckenberg institutes (two located in Frankfurt) at 10 localities in seven German states.
- 15 scientific journals and four popular scientific publication series.
- Proactive involvement in university education.
- Research collections with over 35 million series of plants, animals and rocks.
- Professional management and marketing, with modern structures and resources to support research and education.
- Museums in Frankfurt, Dresden and Görlitz with a total 9,000 m² of exhibition space and more than half a million visits per year.
- International rotating exhibitions.
- Professional museum-based education with a broad programme.
- The Senckenberg school qualifies technical assistants for natural history museums.

The Senckenberg Story

Moving with the times: Senckenberg's Museum in Frankfurt opened in 1907 (right). Senckenberg's Vision for 2017, with a bigger, state-of-the-art exhibition centre.

1817 The *Senckenbergische Naturforschende Gesellschaft* (Senckenberg Nature Research Society) is founded in Frankfurt by local citizens and at the initiative of Johann Wolfgang von Goethe. Johann Christian Senckenberg, after whom the society is named, was one of Frankfurt's leading physicians and philanthropists in the 18th century.

1821 Opening of the Natural Science Artefacts Cabinet in the Senckenbergianum near the Eschenheimer Tor in Frankfurt.

1907 Inauguration of the current museum building in Frankfurt-Bockenheim.

1912 Geoscientist Alfred Wegener presents his continental drift theory to the world at the Senckenberg Institute.

1928 *Senckenberg am Meer* is founded in Wilhelmshaven as SGN's marine research annex.

1945 The main building in Frankfurt is severely damaged following a bomb attack.

1954 Membership of the *Königssteiner Staatsabkommen* (later to become the Blue List, and since 1997 the Leibniz Society).

1969 Opening of the Lochmühle centre for algae and landscape research in the Spessart. Relocation to Gelnhausen in 2006.

1983 Founding of the research station at Messel Pit. The Messel Pit fossil site is declared a UNESCO World Heritage site in 1995.

2000 Integration of the Research Centre for Quarternary Palaeontology *(Forschungsinstitut für Quartärpläontologie)* in Weimar.

The German Centre for Marine Biodiversity Research (DZMB) begins work in Wilhelmshaven and Hamburg.

2008 Renamed as the Senckenberg Gesellschaft für Naturforschung (SGN). Founding of the LOEWE Biodiversity and Climate Change Research Centre (BiK-F), with Senckenberg involvement. Opening of an additional exhibition hall *(Wolfgang-Steubing-Halle)* at the Senckenberg museum in Frankfurt.

2009 The State Natural History Collections in Dresden, the Natural History Museum in Görlitz and the German Entomological Institute in Müncheberg merge with Senckenberg.

2017 Expansion of and additions to the Frankfurt Senckenberg complex and an extension of the exhibition space using adjacent university buildings and the *Physikalischer Verein* (Physics Society).

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