

**Stellungnahme zur
Senckenberg Gesellschaft für Naturforschung -
Leibniz Institution for Biodiversity and Earth System Research,
Frankfurt am Main, Weimar, Wilhelmshaven, Hamburg,
Müncheberg, Dresden, Görlitz, Tübingen (SGN)**

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Vorbemerkung

Die Einrichtungen der Forschung und der wissenschaftlichen Infrastruktur, die sich in der Leibniz-Gemeinschaft zusammengeschlossen haben, werden von Bund und Ländern wegen ihrer überregionalen Bedeutung und eines gesamtstaatlichen wissenschaftspolitischen Interesses gemeinsam gefördert. Turnusmäßig, spätestens alle sieben Jahre, überprüfen Bund und Länder, ob die Voraussetzungen für die gemeinsame Förderung einer Leibniz-Einrichtung noch erfüllt sind.¹

Die wesentliche Grundlage für die Überprüfung in der Gemeinsamen Wissenschaftskonferenz ist regelmäßig eine unabhängige Evaluierung durch den Senat der Leibniz-Gemeinschaft. Die Stellungnahmen des Senats bereitet der Senatsausschuss Evaluierung vor.

Für die Bewertung einer Einrichtung setzt der Ausschuss Bewertungsgruppen mit unabhängigen, fachlich einschlägigen Sachverständigen ein. Ihr stand eine von Senckenberg erstellte Evaluierungsunterlage zur Verfügung. Die wesentlichen Aussagen dieser Unterlage sind in der Darstellung (Anlage A dieser Stellungnahme) zusammengefasst.

Wegen der Corona-Pandemie musste der vom 29. September bis 1. Oktober 2020 vorgehene Evaluierungsbesuch der Senckenberg Gesellschaft für Naturforschung (Senckenberg) in Frankfurt am Main entfallen. Die Bewertung erfolgte im Rahmen eines Ersatzverfahrens, das der Senatsausschuss Evaluierung (SAE) in Umsetzung eines Grundsatzbeschlusses des Senats der Leibniz-Gemeinschaft vom 31. März 2020 eingerichtet hat. Der Senat hält in diesem Grundsatzbeschluss fest, dass das Ersatzverfahren ein Notbehelf ist und ausschließlich auf Einrichtungen angewendet wird, die im Regeltturnus von sieben Jahren evaluiert werden. Die Bewertungen, auf deren Grundlage der Senat Stellung nimmt, sind auf zentrale Kernfragen der Entwicklung und Perspektive einer Leibniz-Einrichtung fokussiert. Ausführliche Einschätzungen und Schlussvoten zu Teilbereichen und Planungen für „kleine strategische Sondertatbestände“ müssen regelmäßig entfallen.

Die Bewertungsgruppe erstellte den Bewertungsbericht (Anlage B). Senckenberg nahm dazu Stellung (Anlage C). Der Senat der Leibniz-Gemeinschaft verabschiedete am 1. Juli 2021 auf dieser Grundlage die vorliegende Stellungnahme. Der Senat dankt den Mitgliedern der Bewertungsgruppe und des Senatsausschusses Evaluierung für ihre Arbeit.

1. Beurteilung und Empfehlungen

Der Senat schließt sich den Beurteilungen und Empfehlungen der Bewertungsgruppe an.

Die Senckenberg Gesellschaft für Naturforschung (Senckenberg) dokumentiert und analysiert die Dynamik des Systems Erde mit einem Fokus auf Biodiversität. Dazu betreibt und entwickelt Senckenberg Sammlungen als „Archive der Natur“, führt naturbezogene Forschungsarbeiten durch und vermittelt die Ergebnisse in die allgemeine Öffentlichkeit, insbesondere über Ausstellungen. Senckenberg vereint sieben Institute und Naturkundemuseen in verschiedenen Bundesländern. Alle sieben Einrichtungen tragen in überzeugender Weise

¹ Ausführungsvereinbarung zum GWK-Abkommen über die gemeinsame Förderung der Mitgliedseinrichtungen der Wissenschaftsgemeinschaft Gottfried Wilhelm Leibniz e. V.

zu einem gemeinsamen, die drei Kernaufgaben Sammlung, Forschung und Vermittlung integrierenden Arbeitsprogramm bei.

Mit insgesamt ca. 40 Millionen Objekten verfügt Senckenberg über die deutschlandweit größte naturkundliche **Sammlung**, die zu den bedeutendsten der Welt zählt. Die Sammlung umfasst unter sehr unterschiedlichen historischen Bedingungen entstandene Teilsammlungen, die erst in jüngerer Zeit institutionell zusammengeführt wurden. Dies stellt erhebliche Anforderungen an das Sammlungsmanagement. Das hohe Potential, das in einer konsistenten zentralen Steuerung der ortsverteilten Teilsammlungen liegt, sollte in den nächsten Jahren noch besser erschlossen werden. Dabei bietet das von Senckenberg entwickelte *Collectomics*-Konzept eine sehr gute Möglichkeit, die Sammlungsentwicklung und die Forschungsarbeit noch besser aufeinander zu beziehen. Die nötigen strukturellen Entscheidungen erfordern nun neben einer engen Abstimmung des leitenden Personals auch eine starke Unterstützung durch die Gremien, insbesondere mit Blick auf die länderübergreifende Koordination.

Die Digitalisierung der Sammlungsbestände ist nach wie vor eine der zentralen Herausforderungen für Forschungsmuseen. Mit 15 % hat Senckenberg derzeit eine etwas höhere Quote erreicht als viele andere naturkundliche Museen in Deutschland. Um weitere notwendige Fortschritte zu erreichen, muss zügig ein standortübergreifendes Digitalisierungskonzept entwickelt werden, in dessen Rahmen die Sammlungsentwicklung und -digitalisierung systematischer als bisher mit den Forschungsarbeiten verknüpft wird. Dabei sollte erreicht werden, die Digitalisierung – als institutionelle Kernaufgabe von Museen im 21. Jahrhundert – über Drittmittel hinaus in noch höherem Maße durch eigene Mittel zu finanzieren.

Senckenberg erarbeitet sehr gute, teilweise hervorragende **Forschungsergebnisse**. Mit dem „geobiodiversity framework“ hat Senckenberg einen schlüssigen und weitgehend einmaligen Leitgedanken entwickelt, um die verschiedenen Forschungsarbeiten aufeinander zu beziehen. Auf dieser Grundlage sollte die Kohärenz der Arbeiten weiter intensiviert werden. Die Publikation der Forschungsergebnisse erfolgt regelmäßig in hochrangigen, international wahrgenommenen Zeitschriften. Insbesondere die Integration der forschungsstarken Einrichtungen *Senckenberg Biodiversity and Climate Research Center* (SBIK-F) und *Senckenberg Centre for Human Evolution and Paleoenvironment* (SHEP) trug seit der vergangenen Evaluierung zu einer Steigerung von Veröffentlichungen in international hochrangigen Zeitschriften bei. Da die klassischen taxonomischen Arbeiten im Zeitalter der globalen Biodiversitätskrise nach wie vor eine unverzichtbare Aufgabe für ein Forschungsmuseum darstellen, sollte diesen auch in Zukunft eine hohe Bedeutung zukommen.

Senckenberg vermittelt Ergebnisse erfolgreich in die breitere Öffentlichkeit, insbesondere über **Ausstellungen** in den drei Museen in Frankfurt am Main, Dresden und Görlitz. Bei der vergangenen Evaluierung war festgehalten worden, dass die Dauerausstellungen in Frankfurt nicht mehr gängigen museologischen Standards entsprechen. Senckenberg hatte dies selbst bereits erkannt und Planungen für eine Verbesserung initiiert. Während umfangreicher Baumaßnahmen in Frankfurt (s. u.) war es kaum zu umgehen, dass die Besuchszahlen in den vergangenen Jahren zurückgingen. Nachdem 2020 in Frankfurt erste Teile einer neuen Dauerausstellung eröffnet wurden, sollte sich die Situation wieder deutlich verbessern, sobald pandemiebedingte Einschränkungen aufgehoben werden können. Auch in

Dresden und Görlitz müssen Steigerungen der Besuchszahlen und eine höhere Sichtbarkeit in der Öffentlichkeit erreicht werden, um dem hohen Anspruch eines führenden Leibniz-Forschungsmuseums gerecht zu werden. Senckenberg sollte sein integratives Konzept für die drei musealen Standorte über gemeinsame Wanderausstellungen hinaus weiterentwickeln, um die mit der institutionellen Zusammenführung angestrebten Synergien auszu-schöpfen und höhere Besuchszahlen zu erreichen.

Senckenberg ist seit 2006 erheblich **gewachsen**. Die institutionelle Komplexität angesichts der noch einmal gestiegenen Anzahl von Standorten, Instituten und beteiligten Ländern wurde bemerkenswert gut gesteuert. Die erste umfangreiche Vergrößerung erfolgte 2009 durch die Integration von drei Einrichtungen in Müncheberg, Dresden und Görlitz. Seitdem wurden zwei weitere Einrichtungen integriert. 2014 wurde das zunächst vom Land Hessen geförderte SBiK-F aufgenommen, 2017 wurde SHEP integriert, das zuvor Teil der Universität Tübingen war (s.o.). Darüber hinaus wurde 2018 mit dem *LOEWE Translational Biodiversity Genomics Centre* (LOEWE TBG) in Frankfurt ein weiteres großes Verbundprojekt etabliert, das vom Land Hessen gefördert wird. Im Zuge dieses Wachstums stieg die Zahl der gemeinsam mit Hochschulen auf Professuren berufenen Beschäftigten von Senckenberg von 3 (2006) über 17 (2013) auf 30 (2020).

Parallel dazu hat Senckenberg ein umfangreiches Renovierungs- und Modernisierungsprogramm mit **Bauinvestitionen** von insgesamt 229 Mio. € durchgeführt. Dies ermöglichte Renovierungen und den Erwerb von zwei neuen Gebäuden für Sammlungen, Büros und Laboratorien in Frankfurt („Masterplan I“), außerdem Baumaßnahmen in Weimar, Müncheberg und Görlitz. Vor kurzem beschloss der Verwaltungsrat erfreulicherweise bis 2035 ein „Neues Museum Senckenberg-Frankfurt“ zu errichten. Dafür sind 316 Mio. € eingeplant. Darüber hinaus sieht Senckenberg eine weitere Vergrößerung durch die Integration des Herbariums Haussknecht der Universität Jena vor, das über 3 Millionen pflanzliche Belege umfasst. In diesem Zusammenhang hat das Land Hessen kurz vor der Evaluierung zusätzliche Mittel der Bund-Länder-Förderung für Senckenberg mit dem Ziel einer „großen strategischen Erweiterung“ ab 1. Januar 2024 beantragt. Der Antrag wird derzeit in einem gesonderten Verfahren durch den Wissenschaftsrat unter Berücksichtigung eines vom Senatsausschuss Strategische Vorhaben (SAS) vorbereiteten Votums des Senats beurteilt, die Entscheidung fällt anschließend in der Gemeinsamen Wissenschaftskonferenz.

Im Mittelpunkt der strategischen Entwicklung der nächsten Jahre muss angesichts dieses intensiven Wachstums in den vergangenen 15 Jahren die **Konsolidierung der bestehenden Aufgaben und Strukturen** stehen. Dabei sollte ein besonderer Fokus darauf liegen, die drei zentralen Aufgaben Sammlungsentwicklung, Forschung und Wissenstransfer noch stärker als bisher in einer systematischen Weise aufeinander zu beziehen. Für alle Forschungsvorhaben sollte jeweils geklärt werden, welcher Beitrag für die Sammlungsentwicklung und den Wissenstransfer erwartet wird. Die Pläne zur Umwidmung von Mitteln der institutionellen Förderung für ein neues Forschungsfeld *Anthropocene Biodiversity Loss* haben ungeachtet der hohen Bedeutung des Themas in der vorgelegten Form auch vor dem Hintergrund der bestehenden *Research Activity 2.2* nicht überzeugt, wie im Bewertungsbericht näher ausgeführt wird.

Die Koordinierung von Standorten in sieben Bundesländern stellt eine große Herausforderung an das **Management** dar. Im Anschluss an eine Empfehlung der vergangenen Evaluierung wird den öffentlichen Geldgebern, insbesondere den beteiligten Ländern, empfohlen, eine maximal hohe Flexibilität bei der Allokation von Mitteln über Ländergrenzen hinweg zu ermöglichen.

Das ruhestandsbedingte Ausscheiden des langjährigen **Generaldirektors** zum 31. Dezember 2020 stellt einen Einschnitt für Senckenberg dar. Er hat seit seinem Amtsantritt 2005 herausragende Arbeit geleistet. Unter seiner Leitung hat sich das Museum zu einem weltweit sichtbaren Wissenschaftszentrum im Bereich der Biodiversitätsforschung entwickelt, charakterisiert durch den konzeptionellen Zugang über die Geobiodiversität. Es ist sehr erfreulich, dass die Position des Generaldirektors nahtlos wiederbesetzt wurde. Auch der neue Leiter ist eine international hoch anerkannte und im Wissenschaftssystem bestens vernetzte Forscherpersönlichkeit. Es wird zudem begrüßt, dass nach einem personellen Wechsel die zeitweise vakante **Administrative Leitung** seit 1. April 2021 wiederbesetzt ist.

Der **Anteil von Wissenschaftlerinnen auf Leitungspositionen** muss weiter erhöht werden. Auf der ersten und zweiten Leitungsebene sind sie nach wie vor deutlich unterrepräsentiert. Es ist erfreulich, dass auf der mittleren Leitungsebene seit der letzten Evaluierung eine deutliche Verbesserung erreicht wurde.

Senckenberg erfüllt die Anforderungen, die an eine Einrichtung von überregionaler Bedeutung und gesamtstaatlichem wissenschaftspolitischen Interesse zu stellen sind. Im Zusammenspiel von Sammlungs-, Forschungs- und Vermittlungstätigkeiten erbringt Senckenberg Leistungen, die in dieser Form von einer Hochschule nicht erbracht werden können. Die Eingliederung in eine Hochschule wird daher nicht empfohlen.

2. Zur Stellungnahme von Senckenberg

Der Senat begrüßt, dass Senckenberg beabsichtigt, die Empfehlungen und Hinweise aus dem Bewertungsbericht bei seiner weiteren Arbeit zu berücksichtigen.

Wie Senckenberg festhält, wird ein Antrag für eine strategische Erweiterung in einem gesonderten Verfahren beurteilt. Die geplante Umwidmung von bereits vorhandenen Mitteln der institutionellen Förderung für den Aufbau eines neuen Forschungsfeldes *Anthropocene Biodiversity Loss* wurde unabhängig von diesem Antrag von den Sachverständigen mit überzeugenden Argumenten kritisch bewertet.

3. Förderempfehlung

Der Senat der Leibniz-Gemeinschaft empfiehlt Bund und Ländern, Senckenberg als Einrichtung der Forschung und der wissenschaftlichen Infrastruktur auf der Grundlage der Ausführungsvereinbarung WGL weiter zu fördern.

Annex A: Status report

Senckenberg Society for Nature Research - Leibniz Institution for Biodiversity and Earth System Research, Frankfurt am Main, Weimar, Wilhelmshaven, Hamburg, Müncheberg, Dresden, Görlitz, Tübingen (SGN)

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1. Key data, structure and tasks

Key data

Year established:	1817
Admission to joint funding by Federal and <i>Länder</i> Governments:	1954
Admission to the Leibniz Association:	1990
Last statement by the Leibniz Senate:	2014
Legal form:	Association (“rechtsfähiger Verein”)
Responsible department at <i>Land</i> level:	Hesse State Ministry for Higher Education, Research and the Arts (other <i>Länder</i> represented in the Supervisory Board: Saxony plus one rotating <i>Land</i> out of Baden-Wuerttemberg, Thuringia, Lower Saxony, Brandenburg, Hamburg)
Responsible department at Federal level:	Federal Ministry of Education and Research (BMBF)

Total budget (2019, cf. appendix 3)

- €44.6 M institutional funding
- €14.5 M revenue from project grants (and €4.7 M ext. administered grants)
- €4.7 M revenue from services
- € 2.6 M revenue from membership fees, donations and other sponsors

Number of staff (2019, cf. appendix 4)

- 287 research and scientific service
- 256 service staff
- 128 administration

Mission and organisation

Purpose according to statutes: *“The purpose of the society is scientific research and education. Its tasks are in particular to conduct research on and in nature, to maintain and develop collections as “archives of nature” and to make them available to science as research infrastructure, to communicate research results to the general public through museums and special exhibitions, through lectures, events and publications, and to train scientists and museum technicians.”*

The Senckenberg Society (*Senckenberg Gesellschaft für Naturforschung, SGN*) is one legal entity and home of the following seven legally dependent research institutes and natural history museums:

1. Senckenberg Research Institute and Natural History Museum (**SF**) in Frankfurt a. M. (Hesse) including:
 - Research Station for River Ecology and Conservation in Gelnhausen (Hesse, part of Senckenberg since 1969)
 - Research Station Messel (Hesse, part of Senckenberg since 1992)
 - Research Station for Quaternary Paleontology in Weimar (Thuringia, part of Senckenberg since 2000)
2. Senckenberg Biodiversity and Climate Research Centre (**S-BiK-F**, part of Senckenberg since 2015) in Frankfurt a. M. (Hesse)
3. *Senckenberg am Meer* (**SaM**, part of Senckenberg since 1928) in Wilhelmshaven (Lower Saxony) including
 - the German Centre for Marine Biodiversity Research (DZMB, part of Senckenberg since 2001) in Wilhelmshaven
 - Research Station of the DZMB in Hamburg
4. Senckenberg German Entomological Institute (**SDEI**, part of Senckenberg since 2009) in Müncheberg (Brandenburg)
5. Senckenberg Natural History Collections (**SNSD**, part of Senckenberg since 2009) in Dresden (Saxony)
6. Senckenberg Museum for Natural History (**SMNG**, part of Senckenberg since 2009) in Görlitz (Saxony)
7. Senckenberg Centre for Human Evolution and Paleoenvironment (**SHEP**, part of Senckenberg since 2017) in Tübingen (Baden-Württemberg), including
 - Research Station Schöningen (Lower Saxony, part of Senckenberg since 2016)

2. Overall concept, activities and results

Senckenberg follows the mission: “Guided by curiosity and responsibility we document and analyze Earth system dynamics with a focus on biodiversity – to benefit science and society”.

All seven institutes contribute to one program portfolio consisting of three Programs: i) Research (which is subdivided into 10 Research Activities), ii) Research Infrastructure and iii) Science & Society (see appendix 1). To reach Senckenberg’s goal of obtaining a systemic understanding of nature, Senckenberg developed a geobiodiversity framework that encompasses all three programs and ranges from curiosity-driven research to applied aspects and dialog with the society. The activities and results of the three Programs are briefly summarized in the following (for details see chapter 7).

Program Research

Senckenberg Research is interdisciplinary and covers a broad spectrum of temporal and

spatial scales, addressing systemic challenges through the following overarching questions:

1. What is the composition and systemic interdependence of the biotic and abiotic world?
2. How did the biotic and abiotic components of the Earth evolve from deep time to the present?
3. How do current ecosystems function, and what can we learn from a past when humans had not yet become a controlling factor?
4. What is the impact of changing land use, climate and other drivers on species, communities, ecosystems and their functioning?
5. To what extent have ecosystem services been exhausted, what could be solutions for a sustainable use of Earth's resources?

The Program Research is divided into four Research Fields (RF) comprising ten Research Activities (RA). In reaction to recommendations of the last evaluation and from the Scientific Advisory Board two RAs were discontinued (see below) and adjustments have been made in the remaining ten RAs.

RF I Biodiversity, Systematics and Evolution is the largest Research Field and much of the research is field- and collection-based and has a organismic focus. It illuminates Earth's diversity in time and space, explores how life evolved and has been distributed on an ever-changing planet and unravels how structure determines functioning of organisms. Using "integrative taxonomy", classical morphological methods of systematics and taxonomy combined with molecular genetic, bioacoustic and other methods. RF I is subdivided in

- RA 1.1 Taxonomy and Systematics,
- RA 1.2 Biogeography,
- RA 1.3 Structure and Function.

RF II Biodiversity and Environment aims at providing a systemic understanding of long-term biodiversity and environmental change, guiding the prospects of long-term ecosystem research (LTER) at national and international levels, developing methods and tools to monitor and assess biodiversity change and its feedbacks on our society to ultimately guide sustainable use and conservation of nature. RF II focuses on the natural variability and Anthropocene human impact on biodiversity on the genetic, species and community levels in various habitats and regions including the environmental drivers. It is subdivided in

- RA 2.1 Long-term Ecosystem Dynamics,
- RA 2.2 Biodiversity Conservation.

Research Field III Biodiversity and Climate is interdisciplinary exploring the interactions among biodiversity, ecosystem processes and climate today and in the geological past. Over the impact of climate on the evolution of genomes to analyzing interactions of society, climate and biodiversity, RF III contributes an essential and integrative element to Senckenberg's geobiodiversity framework. The former RA Adaptation and Climate has

been integrated into the re-arranged RA 3.1 and 3.2. The RF is now subdivided in

- RA 3.1 Geobiodiversity and Climate,
- RA 3.2 Genomic Evolution and Climate,
- RA 3.3 Ecosystem Services and Climate.

Research Field IV Biodiversity and Earth System Dynamics explores the geological, paleoenvironmental and (paleo-)anthropological history of our planet. The feedback between biotic and abiotic processes in the course of earth's history enables an understanding of today's biodiversity. RF IV studies a geological past when humans had not yet become a controlling factor as well as the early dawn of the Anthropocene when interactions among environment, human biocultural evolution and social behavior flourished is key to unravel human-environment interactions. The former RA Marine (Bio-)Sedimentary Systems has been discontinued. The RF is now subdivided in

- RA 4.1 Evolving Earth and Environment,
- RA 4.2 Human Adaptation, Bio-Cultural Diversity and Ecology.

Between 2017 and 2019 Senckenberg published 2,204 articles in peer-reviewed journals, thereof 1,898 in ISI-listed journals (see appendix 2). According to the institute, the number of citations (ISI Web of Science) has increased from ca. 5,000 citations per year in 2012 (year prior to last evaluation) to more than 23,000 citations per year in 2019. Between 2017-2019, Senckenberg published several articles in high-impact journals including: Nature (14), Science (9), Trends in Ecology and Evolution (7), Science Advances (10), Biological Reviews (8), PNAS (9), Nature Geoscience (4), Nature Microbiology (2), Nature Ecology and Evolution (13) and Nature Communications (17).

Program Research Infrastructure

The Program forms the backbone of the Senckenberg's activities. The Knowledge Resources (incl. collections, databases and libraries) are integrated across the Senckenberg institutes. Individual institutes establish, maintain, and develop their respective infrastructures, yet embedded in overarching concepts and structures. Integration is exemplarily shown by the collections, which are spread across all Senckenberg institutes. At approx. 40.5 M collection units with an annual growth of about 250,000, Senckenberg runs Germany's largest natural history collections. Between 2017 and 2019 the collections were physically visited by 1,425 guest scientists.

The digitization strategy prioritizes digitization of specimens that are in high demand (e.g. type specimens, species of difficult taxonomy), where high scientific input is needed to ensure the provided information is valid. Here, the focus is on quality. Bulk digitization is pushed forward in various national and international collaborative projects (see chapter 7 for details). Approx. 6,000,000 collection units are accessible in digital form (15 %). Between 2017 and 2019 the collection database has been accessed 460,000 times.

Senckenberg established a system of interlinked molecular labs, comprising small local labs for use by local researcher groups (e.g. small labs), while central labs with larger equipment serve the entire institution. Other facilities like genomics-technologies, high-

performance isotope labs or imaging technologies are also core facilities across Senckenberg (see chapter 4).

Furthermore, the Program is responsible for the operation of several national and international research platforms for internal and external scientific use, including the three Senckenberg research stations DZMB, Fossil Pit Messel and Schöningen as well as the research vessel and three observatories within the Long-Term Ecological Research (LTER) network and a platform for cultural exchange (Karonga station, Malawi (see chapter 6).

Program Science & Society

To develop systemic solutions for the benefit of nature *and* people, the Program Science & Society follows an integrative, solution-oriented and participatory approach. In 2017 the Program was restructured and expanded. The three Senckenberg museums in Frankfurt, Dresden and Görlitz have a total permanent-exhibition space of approx. 6,800 m² and attracted between 2017 and 2019 on average around 450,000 visitors per year (380,000 in Frankfurt). Since the last evaluation in 2013, Senckenberg has created nine touring exhibitions, reaching another 100,000 visitors per year. In addition, Senckenberg offers guided educational programs for up to 75,000 visitors per year. Senckenberg hosts 25 citizen science projects and collaborates with 1,750 registered citizen scientists and 170 volunteers.

For public relations Senckenberg utilizes a variety of targeted communication instruments, ranging from social media, press work and short movies to publishing science books and articles, a science magazine “Natur-Forschung-Museum” (Nature-Research-Museum) and organizing public lecture series, resulting in almost 29,000 citations/year in the media and more than 30,000 followers/subscribers in various social media formats.

In terms of scientific counseling, Senckenberg engages with politics, administration, NGOs, companies, and society. Examples are given by Senckenbergs contributions to the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IP-BES) or the Intergovernmental Panel on Climate Change (IPCC). At the national level, Senckenberg coordinates the Conservation Research Initiative of the BMBF (*Forschungsinitiative zum Erhalt der Artenvielfalt*) and leads the federal documentation and advisory office on the subject of the wolf. Senckenberg also promotes knowledge and technology transfer (KTT). One example is the spin-off “Phytoprove”.

3. Changes and planning

Development since the previous evaluation

Since the last evaluation in 2014, the following structural and strategical developments were initiated:

1. Integration of SBiK-F: SBiK-F has been funded as a project with ca. 7.2 M € per year by the state of Hesse until 2014 within the LOEWE program (*LandesOffensive zur Entwicklung Wissenschaftlich-ökonomischer Exzellenz* - State initiative for the development of scientific and economic excellence). It has been integrated into Senckenberg

on 1 January 2015 leading to an increase of Senckenbergs core funding of ca. 6.8 M € per year (“*Großer Strategischer Sondertatbestand*”).

2. Integration of SHEP: SHEP has been a collaboration project between Senckenberg and the University of Tübingen and has been integrated into Senckenberg in 2017 leading to an increase of core funding of ca. 2.9 M € per year (“*Kleiner Strategischer Sondertatbestand*”).
3. Establishment of the LOEWE Centre for Translational Biodiversity Genomics (LOEWE TBG): LOEWE TBG is a joint project of Senckenberg and the University of Frankfurt, in which also the University of Giessen and the Fraunhofer Institute for Molecular Biology and Applied Ecology IME are participating. LOEWE TGB consists of already existing groups, extended by four additional professorships (3 W3, 1 W1) covering different fields of genomics. The centre is currently funded by the state of Hesse with a total of 17.6 M € for 2018-2021 within the LOEWE program. Pending a future positive evaluation in 2021, the centre will enter a second development phase from 2022-2024. Ultimately, Senckenberg plans to secure future permanent funding.
4. Collaboration with the Institute for Social-Ecological Research (ISOE) and implementation of social-ecological research: ISOE is the main partner for Senckenbergs increasing activities in the field of social-ecological systems (SES) and has been a founding partner of BiK-F in 2008. By now, social-ecological research is implemented into several third party funded projects, like e. g. the DFG-Research Unit “The role of nature for human well-being in the Kilimanjaro Social-Ecological System” (Kili-SES).
5. New professors and study programs: Senckenberg established 17 new professorships since 2013, jointly appointed with seven universities. Three new study programs were established with Goethe University Frankfurt (1) and the International Institute in Zittau of the TU Dresden (2).

In parallel to the above mentioned developments, between 2013 and 2020 Senckenberg realized a building program (“Masterplan I”) with investments of approx. 229 M€. Funding largely originates from the respective states with substantial contributions from the federal level. See chapter 4 “buildings” for details.

Strategic work planning for the coming years

Appointment of a new Director General and Administrative Director

Senckenberg is currently in the process of appointing a new Director General (starting date 1 January 2021). The search is run as a joint appointment with Goethe University Frankfurt. The selection committee comprised members of the SAB and the Supervisory Board (chair of the search committee), two directors of Leibniz institutes, representatives of the state (Hesse) and federal governments, the president and two Deans of Goethe University Frankfurt, members of the Board of Directors as well as a representatives of Senckenberg scientists. In parallel, Senckenberg is currently also in the process of appointing a new Administrative Director.

Work planning in the three Programs

In an iterative bottom-up/top-down process, which lasted from 2018 to 2020, Senckenberg developed its new strategic work plan 2020-2027. The strategic planning for the **Program Research** focuses on improving a systemic understanding of nature and on increasing the societal relevance of Senckenberg's research by addressing challenges of the Anthropocene. It comprises the following key points:

i) Working towards a holistic understanding of nature requires a conceptual framework that is integrative, interdisciplinary, and systemic. Senckenberg will maintain (and continuously improve and adapt) its geobiodiversity framework that now considers the Anthroposphere as an integral part of the Earth System. Research will be guided by the quest for scientific integrity and excellence, covering curiosity-driven to applied aspects of Earth System Science.

ii) Senckenberg plans to establish a new Research Field V "Anthropocene Biodiversity Loss", focussing with a systemic-transdisciplinary approach on present-day biodiversity loss, its causes and consequences. Senckenbergs preliminary work in this field includes e.g. the recently established BMBF-initiative "Erhalt der Artenvielfalt" coordinated by Senckenberg. The aim is to enhance the value chain from basic research to applications, expand the international network and promote innovative methods, including artificial intelligence (AI), as well as transdisciplinary concepts and approaches, such as social-ecological systems (SES). To implement the new Research Field, additional expertise, infrastructure and resources are required. Senckenberg plans to invest core funds of approximately 1.5-2 M € per year through relocation of existing resources.

In connection with these plans but in a procedure different from this evaluation Senckenberg applies for additional institutional funding. Following an initiative from the State of Thuringia, Senckenberg plans the integration of the Herbarium Haussknecht (Friedrich-Schiller University Jena), which is one of the largest herbaria in Germany with more than three million herbarium records. The aim is to establish a "Senckenberg Centre for Plant Form and Function" at the University of Jena (SJena).

For the full implementation of the new Research Field "Anthropocene Biodiversity Loss" including the establishment of SJena Senckenberg sees the need of a permanent increase of its core budget of 8.8 M € per year ("*Großer Strategischer Sondertatbestand*"). Senckenberg has applied for these additional resources by submitting a proposal to the Joint Science Conference (*Gemeinsame Wissenschaftskonferenz – GWK*) in August 2020. The proposal will be evaluated by the German Science Council (*Wissenschaftsrat – WR*) in a procedure different from the current evaluation by the Senate of the Leibniz Association. Based on a statement by the WR the GWK will decide on this proposal in 2022. In case of a positive decision, Senckenberg would get the additional resources in 2024 .

iii) To balance curiosity-driven and applied aspects of research, new methodological approaches shall be developed and implemented by following three targets: Target #1 will be the expansion of genomic methods in biodiversity research across all four Research Fields, building upon the expertise of LOEWE TBG (see above). Target #2 is to improve the valorization of the collections through a new Collectomics approach by expanding the

breadth of information that can be retrieved from the collections. Using genomic approaches, digitization and AI Senckenberg plans to develop a functional geobiodiversity research build data repositories covering functional aspects. The ultimate goal is to establish a Senckenberg Functional Geobiodiversity Data Hub (SFGD). Target #3 will be to implement the concept of social-ecological systems within the geobiodiversity framework by intensifying the collaboration with ISOE (see above).

The strategic planning for the **Program Research Infrastructure** relies in large parts on the various buildings currently under construction (see chapter 4). Another target is to maintain and further develop Senckenberg's research infrastructure at a state-of-the-art level and to provide the infrastructure basis for the new Collectomics approach. This implies that digitization shall be intensified. While the focus is on quality and on specimens in high demand, bulk digitization shall be pushed forward together with partners from international consortia (see chapter 7 for details).

Regarding the **Program Science and Society**, the core challenge for Senckenberg's museum activities is the vitalization, modernization and expansion of the Senckenberg museum in Frankfurt, the "New Natural History Museum Frankfurt" (see chapter 4 "buildings"). In addition, Senckenberg plans to increase and expand collaborations with citizens and scientific counselling, establishing an inter- and transdisciplinary synthesis, dialog and advisory centre "Natur und Mensch" that uses co-design, co-production and co-dissemination methods to develop systemic solutions for nature *and* people.

4. Controlling and quality management

Facilities, equipment and funding

Funding

In 2019, the Senckenberg Society's revenue from membership fees, donations or other sponsors totalled 2.5 M€ (see appendix 3, line II.). Activities in Frankfurt, Dresden and Görlitz, which are related to the operation of the museums at these locations are almost exclusively financed through these private funds of the Senckenberg Society.

In addition, all seven research institutes and natural museum of the Society (see chapter 1) receive institutional public funding as "Senckenberg Forschungsinstitute und Naturmuseen" (SFN) according to the administrative agreement between the Federal and *Länder* Governments with regard to the joint funding of member institutions of the Leibniz Association (AV-WGL). In 2019, this institutional funding totalled 44.2 M€. Further institutional funding came from the city of Frankfurt (380 T€, see appendix 3, line 1.).

Beside the above-mentioned first and second funding sources Senckenberg receives third party funding for research projects and from its services. In 2019, these funds totalled 23.8 M€ corresponding to 35 % of the overall budget. Revenue for project grants (without externally administered grants) increased from 7.7 M€ (2017) to 14.5 M€ (2019), corresponding to an increase from 14 % to 23 % of the overall budget. Most of the funds came

from Federal and *Länder* governments (35 % to 42 %) and the DFG (32 % to 45 %). Including revenues from externally administered grants (including one ERC Consolidator Grant), the ratio of project grant funds to the overall budget rose from 17 % to 28 %.

From services (e.g. revenues from commissioned work and museum tickets) SGN generated revenue in the amount of 4.7 M€ corresponding to 7 % of the overall budget.

Buildings

Between 2013 and 2020 Senckenberg was able to realize a strategic infrastructure and building program with investments of 229 M€. This building program comprises the following three components:

- SF: The Senckenberg Research Institute and Natural History Museum Frankfurt finalized a renovation and vitalization project (“Masterplan I”) of 137 M € (financed by the State of Hesse, the Federal Ministry of Education and Research, and by private funds of Senckenberg) providing about 25,000 m² of up-to-date collection space, offices and laboratories. This involved selling or dismantling older buildings, restructuring rooms already owned by Senckenberg, and acquisition of two buildings formerly owned by Goethe-University in direct vicinity of the museum.
- SBiK-F: Acquisition and renovation of the Maria-Sybilla-Merian-Haus in Frankfurt. Senckenberg acquired and renovated the “Maria-Sybilla-Merian-Haus” (SBiK-F; 2013). Formerly the pharmacy building of Goethe University, LOEWE provided 22 M € to vitalize this building and implement current standards in labs, and provide offices and meeting rooms for today’s interactive research processes.
- SF: The Research Station for Quaternary Paleontology in Weimar is in the construction phase to modernize and expand its collection space (5 M €).

In addition, the following projects in Görlitz and Müncheberg are confirmed for building and are in the planning phase:

- SMNG: A new collection, office and laboratory infrastructure financed through the State of Saxony and the German federal government will host the institute in Görlitz. Project volume is 56 M € with a projected completion in 2024.
- SDEI: The institute in Müncheberg will gain laboratory, collection and office space through the addition of a laboratory wing in particular for genetic studies. Project volume is 8.8 M € with a projected completion in 2022.

Furthermore, in the long term, Senckenberg plans to renovate and expand the Senckenberg museum in Frankfurt (“Masterplan II”). So far, a concept for the “New Senckenberg Natural History Museum Frankfurt” has been developed. It includes a structural upgrade of the museum, an extension building of about 7,000 m² as well as a new exhibition concept. Senckenberg is in dialog with the funding authorities, including the state of Hesse, the BMBF and the German parliament, exploring options to raise the necessary funds of about 360 M € for the realization of this project. In addition, also private funds shall be raised.

Laboratories and equipment

The Senckenberg laboratories are structured into three categories depending on the user spectrum: group labs (cat. I), site labs (cat. II) for the respective institute, and central facilities (cat. III) serving all Senckenberg groups. Sample/specimen preparation, collection of ecological data and imaging are typically handled by cat. I or II, whereas labs for chemical/physical analyses and genetic laboratories are represented in all three categories. The most important infrastructures are:

- At SF (Frankfurt): The Micro Computer Tomography and Scanning Electron Microscopy (together with SaM and SHEP), the X-ray and virtual 3D analyses of fossils (together with SHEP) and the Grunelius-Möllgaard DNA laboratory and archive.
- At S-BiK-F (Frankfurt): The Molecular Laboratory Centre, the Mesocosm-Hall, the Stable Isotope Laboratory (jointly run with Goethe University Frankfurt) and the Data and Modelling Centre.
- At SNSD (Dresden): The Molecular-genetic Lab with the aDNA System and the LA-ICP-MS (Laser Ablation with Inductively Coupled Plasma Mass Spectroscopy) Geochronology Lab.

Following the successful grant award for a computer tomography system (SHEP), the commissioning of a “CT Facility” operated jointly with the University of Tübingen is being planned for the year 2020. The large data volume generated by NGS requires an increased bioinformatics expertise. In this field, the LOEWE-TBG supplements Senckenberg’s laboratory infrastructure. Through LOEWE TBG a (virtual) Senckenberg Genome collection has been put together.

Furthermore, Senckenberg runs its own research vessel. A new concept for running and replacing the research vessel has been established (see chapter 7).

Organisational and operational structure

Organisational structure

Senckenberg is managed by a 5-member Board of Directors. It consists of the Director General, who determines the strategic direction of the institution, an Administrative Director, who is responsible for the administration and three other members, who manage the three Senckenberg Programs. The Board is advised by the Scientific Committee, which consists of the heads of institutes, the speakers of the Research Fields and Programs, as well as nine scientists, elected by all scientists across Senckenberg.

The seven Senckenberg Institutes are composed of (at least two) divisions further divided into sections. They are managed by the respective institute director, who reports to the Board of Directors and is the first contact person for the central administration in Frankfurt in all administrative matters. Since the Senckenberg Society is one legal entity, the Senckenberg Institutes are legally dependent. Regular conferences are held between the Board of Directors and the institute directors (including their administrative managers) to coordinate all relevant organizational topics. The management of the institutes is based on the budgets defined in the annual program budget for each institute (see below). All institutes have their own budget responsibility.

Operational Structure

According to Senckenberg's matrix structure, all institutes and their staff members contribute to Senckenberg's program portfolio (Research, Research Infrastructure and Science & Society). The subunits (Research Activities) are led and managed by elected speakers. Senckenberg's Programs are developed in a top-down and bottom-up process that includes all of Senckenberg's bodies (see below).

The program budget describes for each financial year a) the planned activities for the three Programs, including their budget, as well as b) the budgets for the seven institutes and their contributions to the Senckenberg Programs. The program budget is developed by the Board of Directors in consultation with the speakers of the three Programs and with the directors of the institutes.

In a first step, the Programs with their activities are designed in a set of retreats, organized by the Program and Research Field speakers. In a second step the institute directors are asked to draft their respective budget, based on the planned activities in the three Programs. In a joined meeting of the Board of Directors and the institute directors adjustments are made and the budgets are finalized. As a next step, the members of the Board of Directors write a first draft of the program budget (describing the program activities, their budgets and the budgets of the institutes), which is then discussed in several bodies before it is adopted by the Supervisory Board (see below for a description of SGN's bodies).

The performance and success are monitored in a similar way. All staff members enter their key performance indicators into a central data base and report results in specific retreats. Based on this information, the Program speakers and the Board of Directors write a first report on the fulfilment of the Program objectives and key performance indicators. This first report about the program performance is supplemented by a financial report covering the income and expenditure of the Programs and institutes, provided by the central administration. Based on this information a first draft of the report on the use of funds is written. It is then discussed and commented by the same bodies as the program budget (see above) and adopted by the Supervisory Board and the Members Assembly.

Quality Management

The publication strategy is based on four pillars: i) Scientists are encouraged to publish in internationally recognized, cross-disciplinary, peer-reviewed journals. ii) Taxonomic or systematic research and associated monographs (revisions) provide long-term cornerstones of science. The publication strategy takes into account the different priorities of the researchers during different career stages and recognizes the importance of career-defining publications. iii) Senckenberg publishes journals targeted at the interested layperson audience or policy makers. These publications in German address topics of broad interest and are integrated into the Science & Society strategy. iv) Senckenberg also acts as a publishing house. After a reorganisation in the last years, Senckenberg now maintains two broad-scope ISI-listed journals in cooperation with a publisher, and three reviewed yet more specialized journals serving e.g. specialized taxonomists including citizen scientists. The various series for monographies were merged under one roof.

Collections are routinely monitored for quality by the responsible curators. In terms of usage, a reporting scheme covers loans and visitors. Since 2013, Senckenberg has introduced collection groups across all collections. While maintaining more than 170 individual collections, SGN additionally introduced groups for geology/paleontology, insects, misc. invertebrates, vertebrates and DNA-archives. Curators-in-charge meet at least once a year and discuss overarching issues.

Senckenberg follows the Guideline on the Handling of Research Data of the Leibniz Association (2018). Senckenberg, has committed itself to the FAIR principles (findable, accessible, interoperable and reusable), revised its IT strategy to build the necessary structures, and recently formulated a research data policy. A new scientific coordinator has recently been employed to further develop and coordinate the processes across Senckenberg. Working group leaders are obliged to monitor compliance with the data policy.

The basic framework of the Data Protection Officer (DPO) consists of Senckenberg's data protection guideline. In accordance with the Basic Data Protection Regulation (DSGVO), this regulates the compliant processing of information and the resulting responsibilities.

The laboratories follow the quality controls and documentation needs that are state-of-the-art in the respective field. For the larger structures SGN monitors internal and external orders as a quantitative indicator.

To advance technology transfer, a knowledge and technology transfer office (KTTO) was established through BMBF and LOEWE funding. The KTTO offers support with technology transfer related funding, intellectual property, cooperation with industry and the founding of spin-offs. The KTTO also organizes events, meetings and workshops and establishes networks with external stakeholders.

The demand and performance driven resource allocation is organized by the institutes and the Board of Directors in the program budget (see above). The most important performance incentive is set through overhead funds associated with external funding. 50 % of the overhead reside within the central administration whereas the remaining 50 % go to the institute and in consequence to the PI where the external funds were raised.

Senckenberg developed a set of rules for safeguarding of Good Scientific Practice (GSP) based on the Leibniz guidelines and also considering the DFG code "*Leitlinien für die gute wissenschaftliche Praxis*". These rules serve as a tool to prevent scientific misconduct and to assure scientific integrity in the entire research process. All Senckenberg scientists have to pass an annual, web-based questionnaire on rules and regulations of good scientific practice. Particular emphasis is placed on falsification and manipulation of data, plagiarism and conflicted authorship, lack of supervision, conflict of interests and hindering work of others. Furthermore, the Senckenberg rules outline responsibilities and functions of the two elected Ombudspersons, membership and role of an inquiry panel, and potential consequences for scientific misconduct.

Quality management by supervisory board and advisory board

The Supervisory Board (*Verwaltungsrat*) appoints the members of the Board of Directors, the institute directors and heads of divisions. It is chaired by the President of the Senckenberg Society and comprises representatives of the Senckenberg society (elected by the Members Assembly), federal and state funding authorities (delegate), the city of Frankfurt (delegate) the Dr. Senckenbergische Stiftung (delegate) as well as regular guests. Important tasks of the Supervisory Board are the approval of the program budget and the adoption of the annual accounts (*Jahresabschluss*) and report on the use of funds (*Verwendungsnachweis*). It also prepares the annual Members Assembly of the Senckenberg Society and the corresponding proposals for resolutions. Meetings and resolutions of the Supervisory Board are prepared by its Executive Committee. Both meet between 3 and 5 times per year.

The Scientific Advisory Board (SAB) advises the Board of Directors and the Supervisory Board in all tasks, plans and decisions that relate to Senckenberg's program portfolio. The SAB monitors and evaluates Senckenberg's scientific work program, and makes proposals for Senckenberg's further development. The SAB also presents an annual report to the Supervisory Board and carries out an audit between two evaluations as it is common for Leibniz institutes. In addition to the SAB, also the Board of Trustees, under the patronage of the Prime Minister of Hesse, together with representatives of other institutions and commercial enterprises, provides impulses to the Board of Directors and the Supervisory Board for further developments.

5. Human Resources

Management

Senckenberg generally fills the positions of institute directors and division heads by joint professorial appointments through cooperation agreements with universities. The recruitment procedures follow the "Standards for the appointments of academic management positions within the Leibniz Association". In summary, 30 employees of Senckenberg hold W3/C4- or W2/C3-professorships at universities and 9 employees hold extraordinary or honorary professorships (see table below).

City of University	Number of professors (W3/C4 or W2/C3)	Number of professors (extraordinary or honorary)
Frankfurt am Main	14	1
Tübingen	6	1
Dresden	3	2
Oldenburg	2	-
Bremen	1	-
Duisburg-Essen	1	-
Halle-Wittenberg	1	-
Gießen	1	-
Mainz	1	-
Freiberg	-	1

Jena	-	1
Leipzig	-	2
Zittau Görlitz	-	1

Since 2013 Senckenberg has hired 9 new professors and 8 Senckenberg scientists were awarded full professorship positions either in response to competing professorial offers or through awards in competitions (e.g. Leibniz programme for female professors, professorship financed by the Bosch foundation).

Postdoctoral staff

An international call for applications is used to fill positions for section heads or postdocs. In both cases, a selection committee is set up to select applicants. Senckenberg offers three different postdoctoral career opportunities: i) Postdoctoral scientists with tenure track option, ii) Junior group leaders with tenure track option, and iii) Postdoctoral scientists on fixed-term contracts (including externally funded).

Support of all postdoctoral staff (and scientific staff in general) follows the “Guidelines for the working conditions and career development of pre-doctoral and postdoctoral researchers in the institutes of the Leibniz Association”. Key support measures include collaboration with universities (e.g. through teaching and development of joint labs), mentoring through a 2-person committee, support in preparing grant applications, encouragement to spend time at partner institutions and invite scientists to Senckenberg or contributions to international conferences. All postdoctoral scholars are encouraged to make use of career development opportunities, e.g. from the graduate academies (e.g. on project management, group leadership, guidance of students, didactics in teaching, conflict management).

Postdoctoral positions with tenure track and junior group leader positions are offered for three plus three years. For the tenure process there is a transparent catalog of criteria. In the ideal case, an interim, guiding evaluation takes place after three years with a final evaluation after five years upon which the Board of Directors decides upon tenure. The evaluation committee at these evaluations comprises one member of the Board of Directors, the director of the respective Senckenberg institute, the mentor(s) of the candidate and the equal opportunity officer. If deemed necessary, the Board of Directors can solicit external written review(s). Since the establishment of the Senckenberg tenure-track program in 2014 out of 22 candidates 16 were awarded tenure after successful completion of the program (73 %).

Since the last evaluation, 20 postdoctoral researchers were awarded or offered professorships or leading positions at other institutions. In addition, 11 employees successfully completed their habilitation.

Doctoral Candidates

As of 31 December 2019 there were 57 PhD candidates working at Senckenberg (including 8 scholarship recipients, see appendix 4). Between 2017 and 2019 114 doctoral candidates of Senckenberg successfully completed their work. On average, a doctorate took ca. 4.5 years. Publication-based doctoral thesis are the norm.

Senckenberg recommends that doctoral candidates be remunerated at 65% of a full-time academic salary and that they sign supervision agreements in which target agreements are made. These target agreements are evaluated regularly by the doctoral candidate and supervisor and adjusted if necessary.

All doctoral candidates are eligible to participate in structured doctoral programs, e.g. the GRADUATE Academy of TU Dresden, or GRADE - Goethe Research Academy for early career researchers at Goethe University Frankfurt. Both offer its members a training program, focused on research, career and personal development. The General Director of Senckenberg was the founder of GRADE. It also offers a specialized program that is adapted to the topical interests of Senckenberg. One of Senckenberg's professors is spokesperson of the program.

An Alumni Network has been implemented in 2016. Via the network, alumni are informed about Senckenberg activities and research highlights and can apply for reunion grants to return to Senckenberg for continuing cooperative projects. Of the 107 alumni students in the network, 81 currently work at universities or non-university research institutions, 14 in NGOs or in public service positions and 12 started a business career.

Non-scientific staff

Senckenberg runs and operates a state-certified school for museum technicians (*Senckenberg-Schule*), where scientists and technicians impart knowledge and skills in science-supporting activities for natural history museums and research institutes. Up to 20 students are admitted who complete their training as technical assistants in two-year intervals. In addition, since the last evaluation vocational training courses have been offered and completed for office management assistants and specialists in media and information services.

Senckenberg supports employees who are continuing their education in extra-occupational courses of study as part of the mostly administrative tasks they perform, and offers the opportunity for professional orientation and qualification. Students acquire professional skills in internships, e.g. in communications; young lawyers/assessors complete their legal clerkship in the legal division of the general administration.

The museums in Frankfurt, Görlitz and Dresden offer traineeships (*Volontariate*), in which university graduates become acquainted with all fields of activity relevant to the operation of a museum.

Equal opportunities and work-life balance

Equal opportunities

As of 31 December 2019, out of 287 employees in "Research and scientific services" 115 were female (40 %). Out of the 8 scientific directors one was female (12.5 %). Among the 25 division heads were 5 women (20 %). Out of 94 group leaders (including 8 junior groups) 34 were female (36 %). Among the 111 scientists in non-executive positions were 55 women (50 %). Out of the 57 doctoral candidates (including 8 scholarships) 23 were female (40 %).

The under-representation of women in leadership positions is a topic continuously addressed by the Board of Directors, the Supervisory Board and the Scientific Advisory

Board. Measures to attract more women to leadership positions include *ad personam* hires, active application requests, searches in specialist data bases, or advertisements in specialist networks. According to Senckenberg, the most efficient tool is the tenure-track program (see above). Since its establishment in 2014 12 women obtained permanent scientist positions at Senckenberg.

Senckenberg adopted and implemented several guidelines (including the Leibniz equal opportunity standards) which serve to promote equal opportunity. In particular, Senckenberg implemented the so-called cascade model as recommended by the Leibniz Association. However, Senckenberg does not yet meet all goals of the cascade model.

The gender equality officers are involved in all personnel measures. Financial resources are made available e.g. for allocations by the gender equality officers, targeted support of female (non)academics, or measures to combine work and family. The working group on gender equality consists of the gender equality officers and the Board of Directors.

Work life balance

Employees are supported in combining work and family responsibilities through various measures like i) flexible working hours and locations (home office possibilities) as well as temporarily reduction of working time, ii) 8 places in day care center jointly operated with another Leibniz institute in Frankfurt (Leibniz Institute for Research and Information in Education, DIPF), iii) financial contribution to care costs for children and relatives in need of care, during conferences or research stays abroad, as well as in the context of further training or internal events (*Notfallbetreuungsfond*), iv) children support programs during holidays, v) parent-child-offices and scheduling meetings during the opening hours of daycare centers and schools or vi) contract extension for maternity protection and parental leave for internally and externally funded contracts

The re-entry of employees after parental leave is aided by early contact offers, which also provide information on further training, exit (prior to the parental leave) and return talks. If required, financial support for the completion of qualification theses is possible.

When hiring new employees, Senckenberg provides support in the search for a professional perspective for partners. Senckenberg is a member of the Dual Career Networks Metropolregion Rhein-Main and *Mitteldeutschland*.

Since 2012, Senckenberg has been certified by the audit "berufundfamilie" (conferred through the berufundfamilie Service GmbH after full evaluations). In 2016 and 2019, Senckenberg has been re-certified successfully.

6. Cooperation and environment

Cooperation with universities

Senckenberg cooperates with 60 German universities in the framework of joint professorial appointments, the training and promotion of doctoral students (cf. chapter 5), joint scientific endeavours and academic teaching. Senckenberg names the universities in Frankfurt, Tübingen and Dresden as the main partner universities.

At Goethe University Frankfurt, Senckenberg professors contribute to the Bachelor of Science (BSc) programs in Biology and Geosciences as well as to the Master of Science (MSc) programs in Ecology and Evolution, in which Senckenberg scientists are responsible for eight Master modules. At the University of Tübingen the Bachelor and Master programs in Prehistory and Paleoanthropology are in large parts run by the joint appointments at SHEP. At the International Institute Zittau of the TU Dresden Senckenberg designed and implemented the Master program Biodiversity and Collection Management as well as the program Biodiversity and Ecosystem Services. Each semester, approximately 70 Senckenberg scientists teach around 300 SWS (teaching hours per week during the semester), covering the fields of biology, geology, paleontology, crystallography, meteorology, prehistory, paleoanthropology, and geography.

Since the last evaluation in 2013, Senckenberg scientists have been involved in the following third party funded collaborative research projects 11 DFG-Research Units (FOR), 9 DFG-Priority Programs (SPP), 1 DFG-Collaborative Research Centre (SFB), 2 DFG-Excellence Clusters (EXC), 1 DFG-Research Centre (FZT), 2 DFG-Research Training Groups (GRK), 1 Academy Program, and 29 BMBF-Collaborative Projects.

Cooperation with non-university partners

Among the non-university research institutions, ISOE – Institute for Social-Ecological Research is the most important partner institution (see chapter 2). In the Leibniz-Association, Senckenberg collaborates with 21 institutes in individual joint projects. Furthermore, Senckenberg is member in two Leibniz Research Alliances and three Leibniz Research Networks. Since 2017, the director of SBiK-F is Vice President of the Leibniz Association, the Senckenberg General Director is speaker of the network of the eight Leibniz Research Museums and of the Leibniz Research Network “Integrated Earth System Research”. Within the DCOLL initiative¹ consortium, Senckenberg collaborates with six partner institutions including three Leibniz institutes, to become part of the German national roadmap for research infrastructures.

There are also multiple collaborations with institutes of the other three non-university research alliances in Germany, the Max Planck Society, the Helmholtz Association and the Fraunhofer-Gesellschaft.

Cooperation through international Joint Projects and Programs

Senckenberg is a member of the Consortium of European Taxonomic Facilities (CETAF). CETAF aims to promote scientific research and access to European collections and enables partnerships to exploit European funding opportunities as a voice for taxonomy and systematic biology in Europe. CETAF has been instrumental to launch the Distributed System of Scientific Collections (DiSSCo). Over 110 different institutions joined forces to work towards a digital exchange platform in the framework of an ESFRI research infrastructure. Its foundations are currently established in the DiSSCoPrepare project, where

¹ DCOLL = *Deutsche Naturwissenschaftliche Sammlungen als integrierte Forschungsinfrastruktur* (German Natural Sciences Collections as an Integrated Research Infrastructure)

Senckenberg is one of seven institutions taking the lead. DiSSCo steers a range of projects at a total of over 80 M €. An example is the Pan-European Network SYNTHESYS+ where Senckenberg also is partner. SYNTHESYS+ is funded by the European Union to facilitate access to collections, both in form virtual access and physical access. This includes physical loans, destructive and non-destructive sampling and also a standardization of DNA-extraction, sequencing and sequence curation for museum specimens.

Senckenberg is engaged in the International Long-Term Ecological Research (ILTER) network and became the Science Chair and Member of the Executive Committee of ILTER in 2017. It took over the chairmanship of the German LTER network (LTER-D) in 2013. Senckenberg is also a member of the “Operational Planning Group” of the European eLTER Research Infrastructure that is steering the European ESFRI roadmap process since 2017. This group is also supervising two EU funded projects (eLTER PLUS, eLTER PPP) with more than 30 partners from 27 countries (14 M € in total).

In the Project GEANS (Genetic tools for Ecosystem health Assessment in the North Sea region) nine partners from seven countries around the North Sea aim at harmonizing and consolidating existing genetic tools and methods for ecosystem monitoring in North Sea Region. GEANS is part of the Interreg North Sea Region programme funded by European Regional Development Fund.

Senckenberg works together with several partners from Russia and Germany in a collaboration on the biology of the bathyal, abyssal and hadal faunas of all size classes (meio-macro-, and megabenthos) that has been performed in the NW Pacific Ocean.

Senckenberg maintains a collaboration with the Institute of Tibetan Plateau Research, and plays a coordinating role in the international program “Third Pole Environment” (TPE), which studies the role of the Tibetan Plateau under Anthropocene climate change.

There is also a research cooperation with several institutes in Mongolia including the National University of Mongolia, the Mongolian Academy of Sciences and various national parks.

Senckenberg has been active in West African countries (Burkina Faso and Benin) for more than 20 years, recent activities also include the study of biodiversity and social ecological systems in Tanzania.

Senckenberg is also strongly involved in IPBES, e.g. with several coordinating lead authors and lead authors in different assessments (see chapter 2).

The LOEWE Centre for Translational Biodiversity Genomics has teamed up with two major, international consortia on biodiversity genomics: the European Molecular Biology Laboratory (EMBL) Europe’s flagship laboratory for the life sciences and the Earth Bio Genome Project.

Institution’s status in the specialist environment

Senckenberg’s most important peers, competitors and partners in Germany are the *Museum für Naturkunde* in Berlin (MfN), the *Zoologisches Forschungsmuseum Alexander Koenig* in Bonn (ZFMK), and the DFG-funded Research Centre “German Centre for Integrative Biodiversity Research” (iDiv) in Halle/Jena/Leipzig.

On an international scale peers, competitors and partners are The Natural History Museum (NHM) in London, the American Museum of Natural History (AMNH) in New York, and the Smithsonian National Museum of Natural History (NMNH) in Washington.

According to its own information Senckenberg is unique with respect to its peers by the combination of

- More than 200 years of tradition as an association, with about 7,000 members
- A composite federal organization with seven institutes in seven of Germany's 16 States, thus having a nation-wide representation
- A broad expertise and collections covering disciplines such as evolution, systematics, botany, zoology, mycology, terrestrial, freshwater and marine research, molecular biology, genomics, biogeography, ecology, geology, paleontology, mineralogy, crystallography, meteorite science, prehistory, paleoanthropology, biodiversity and climate modeling, and social ecology,
- A systemic, inter- and transdisciplinary geobiodiversity framework
- Following a research philosophy to make maximum use of the value chain from ideas to applications
- Three museums and innovative dialog and transfer concepts which jointly provide the platforms for knowledge transfer and discourse

7. Subdivisions of SGN

1. Program Research

Research Field I: Biodiversity, Systematics and Evolution

Research Activity 1.1: Taxonomy and Systematics

[36.4 FTE Research and scientific services, 6.2 FTE Doctoral candidates, and 8.7 FTE Service staff]

The mission of RA 1.1 is to illuminate Earth's diversity in time and space. It studies the variability of species, describes relationships among species and higher taxa, and provides a baseline of nature's diversity for other biological disciplines and systemic research on nature in particular in times of rapid Anthropocene biodiversity decline. RA 1.1 provides a core competence of Senckenberg and is interconnected with all other RAs. It is field- and collection-oriented, has a organismic focus and considers past and present biodiversity.

Key questions focus on (1) how species can be characterized and which variation patterns can be recognized morphologically, and also at genetic or genomic levels; (2) how species are delimited from each other or whether their populations are still connected and (3) how species or higher taxa are related to each other (phylogeny). Since the previous evaluation, based mainly on the collections it described 1,267 new species and subspecies, 153 genera, ten families and one new order (Alienoptera). RA 1.1 has advanced efforts in integrative taxonomy combining morphological methods in systematics and taxonomy with molecular genetics and genomics. Based on the expanded DNA and tissue collections RA 1.1 plans to further enhance collection based research.

Between 2017 and 2019 the RA published 873 articles in peer-reviewed journals. The revenue from project grants totalled approx. 3.8 M€ (Ø 1.3 M€ p.a.), with 1.8 M€ spent from federal and *Länder* governments, and 850 k€ from the DFG. In addition, 1.1 M€ were spent from revenues from commissioned work. In the same period, 29 doctoral degrees and two habilitations were completed.

Research Activity 1.2.: Biogeography

[12.5 FTE Research and scientific services, 1.4 FTE Doctoral candidates, and 2.2 FTE Service staff]

RA 1.2 aims at elucidating range dynamics and their driving forces in time and space as a key element of nature conservation and the understanding of social-ecological systems. Key questions address (1) how species and their subunits are distributed and why, (2) what larger patterns can be recognized in the distribution of different species or higher taxa, and (3) how and by what means distribution patterns have changed through time.

Since the last evaluation, RA 1.2 has studied most of the major organismic groups, in almost all regions of the world, and in terrestrial, limnic and marine environments. Although the approach is global two core foci in biogeographic research have crystallized: the marine environment and the Qinghai-Tibet Plateau. Following a recommendation of the last evaluation, RA 1.2 has intensified the inclusion of paleontological research into biogeography and has enhanced capacities in using genetic methods (e.g. genomics, Next generation sequencing). The use of increasingly advanced analytical methods, especially in genetics and modeling, allowed for new insights by analyzing old collection material, opening the field of “Collectomics”.

Between 2017 and 2019 the RA published 390 articles in peer-reviewed journals. The revenue from project grants totalled approx. 1.2 M€ (Ø 400 k€ p.a.), with 640 k€ spent from the DFG and 360 k€ from federal and *Länder* governments. In the same period, 12 doctoral degrees and one habilitation were completed.

Research Activity 1.3.: Structure and Function

[11.5 FTE Research and scientific services, 1.3 FTE Doctoral candidates, and 1 FTE Service staff]

The mission of RA 1.3 is to study organismic structures and their functions – to understand how organisms function and interact with their environment, and to transfer organismic functions into applications. Key questions are (1) How is a particular organism, or some part of it, structured and how does structure correlate with function? (2) What are the structural and functional similarities and differences between different organisms? And, (3) how did structures and their functions change during evolution?

One core competence of RA 1.3 is its largely collection-based morphological study of extant and extinct organisms. A developing second core competence are genomic studies, mainly through the new LOEWE TBG. The work is mostly basic research, but mechanical principles of organisms are also transferred into applications (bionics) and natural products are explored for their use in medicine or as materials.

Between 2017 and 2019 the RA published 182 articles in peer-reviewed journals. The revenue from project grants totalled approx. 1.5 M€ (Ø 500 k€ p.a.), which were almost entirely raised within the competitive procedure of the Leibniz Association. In the same period, four doctoral degrees and two habilitation were completed

Research Field II: Biodiversity and Environment

Research Activity 2.1: Long-term Ecosystem Dynamics

[11.2 FTE Research and scientific services, 0.8 FTE Doctoral candidates, and 6.3 FTE Service staff]

RA 2.1 is pursuing the mission of generating and analyzing systemic long-term (approx. 10-100 years) biodiversity and environmental data and trends. Research is based on three pillars: 1) generating and analyzing systemic long-term biodiversity and environmental data in four flagship observatories that are embedded in the global network “International Long-Term Ecological Research” (ILTER), 2) using competences in time-series analyses beyond the four observatories by analyzing biodiversity and environmental data at different spatial scales across the globe, and 3) guiding long-term ecological research at the international level by developing conceptual frameworks and monitoring methods (e.g. environmental DNA as part of LOEWE TBG) as well as participating in respective scientific organizations.

RA 2.1 contributed to the successful application of the European LTER Research Infrastructure (eLTER RI), which is now part of the EU Research Infrastructure roadmap (ESFRI). Future plans include the strengthening of social-ecological research within the four observatories to support local stakeholders and to develop tailored conservation measures to mitigate human impact on ecosystems going from ideas to application. Furthermore, RA 2.1 shall contribute to studying Anthropocene biodiversity loss by providing expertise in time series analyses.

Between 2017 and 2019 the RA published 180 articles in peer-reviewed journals. The revenue from project grants totalled approx. 4.2 M€ (Ø 1.4 M€ p.a.), with 2.2 M€ spent from the DFG and 1.1 M€ from federal and *Länder* governments. In addition, 165 k€ have been raised from commissioned work. In the same period, 7 doctoral degrees and one habilitation were completed.

Research Activity 2.2. Biodiversity Conservation

[19.7 FTE Research and scientific services, 4.4 FTE Doctoral candidates, and 4.2 FTE Service staff]

The mission of RA 2.2. is to develop and conduct assessments of local and global biodiversity change, including feedbacks on human society, with the ultimate goal to guide future conservation. Work considers both direct human impact (i.e. land use change) as well as abiotic environmental drivers that affect land use, biodiversity and the way both interact.

Assessments cover major realms from marine and freshwater to terrestrial habitats, explicitly also considering understudied taxa. Developments of methods comprise genomic monitoring approaches that include reconstruction of the recent recolonization of wolves in Central Europe or tools for automated Red List assessments based on classic occurrence data as

those kept in the collections. RA 2.2. provides practical advice in terms of conservation and mitigation measures such as schemes for restoration of freshwater environments, a data warehouse on agricultural practices and soil biodiversity, or policy advice on sustainable grazing practices in dry range lands.

Between 2017 and 2019 the RA published 314 articles in peer-reviewed journals. The revenue from project grants totalled approx. 4.8 M€ (Ø 1.6 M€ p.a.), with 2.1 M€ spent from the United Nations Environment Programme (UNEP), and 1.7 M€ from federal and *Länder* governments. In addition, 3.1 M€ have been raised from commissioned work. In the same period, 13 doctoral degrees were completed.

Research Field III: Biodiversity and Climate

Research Activity 3.1.: Geobiodiversity and Climate

[24.4 FTE Research and scientific services, 10.8 FTE Doctoral candidates, and 0.3 FTE Service staff]

RA 3.1. explores the interactions among biodiversity, ecosystem processes and climate today and in the geological past and builds models to predict future impacts of climate change. It uses a functional geobiodiversity approach to integrate biosciences and geosciences and link empirical research and modeling over different time scales. Results are relevant for evaluating and planning climate-change adaptation strategies, by assessing potential impacts of mitigation measures on biodiversity.

Research Activity 3.1 reconstructs past geobiodiversity dynamics, with a particular focus on mountain systems. It intergrates isotope geochemistry and paleontological studies with evolutionary and ecological approaches as well as climate and vegetation modeling. Work in present ecosystems focuses on climatic gradients in tropical mountains. Here, the RA measures species' functional traits in museum collections and contributes to the development of new trait databases and concepts. Another activity is the development of regional to global vegetation models that include novel components, such as trait variation, biotic interactions, and vegetation-climate feedbacks. The RA operates two research infrastructures: the joint Goethe University-Senckenberg SBiK-F Stable Isotope Facility and the Senckenberg Data and Modeling Centre.

Between 2017 and 2019 the RA published 398 articles in peer-reviewed journals. The revenue from project grants totalled approx. 5.5 M€ (Ø 1.8 M€ p.a.), with 3.8 M€ spent from the DFG and 700 k€ from federal and *Länder* governments. In addition, 1.6 M€ have been raised from revenue from externally administered grants. In the same period, 30 doctoral degrees were completed.

Research Activity 3.2.: Genomic Evolution and Climate

[10.5 FTE Research and scientific services, 2.3 FTE Doctoral candidates, and 1.5 FTE Service staff]

The RA investigates the impact of climate on the evolution of genomes. The focus lies on understanding 1) the genomic basis of climate adaptation, 2) the genetic response of interacting communities to climate, and 3) the influence of climate on genome architecture and

variation. The RA uses the present genomic diversity to infer past evolutionary processes, and to extrapolate future developments through integrative modeling approaches. The RA the lead funding acquisition and management of the LOEWE TBG project.

The core competence lies in testing and advancing conceptual approaches at the intersection of ecology and evolution. The RA integrates methodological approaches in genomics and molecular biology, data science and bioinformatics, in combination with field and laboratory experiments. Experimental work is mostly performed in the Mesocosm Hall, an experimental infrastructure with climate chambers and terrestrial mesocosm facilities that allows to simulate a wide range of climate conditions. The RA does mostly fundamental research, but also application-oriented, societally relevant research, e.g. predicting the climate-responses of invasive mosquitoes, or harnessing value from biodiversity in application-based contexts.

Between 2017 and 2019 the RA published 152 articles in peer-reviewed journals. The revenue from project grants totalled approx. 1.8 M€ (Ø 600 k€ p.a.), with 1.1 M€ spent from federal and *Länder* governments and approx. 470 k€ from the DFG. In the same period, 13 doctoral degrees and one habilitation were completed. Two scientists trained in this RA have recently secured professor positions at the University of Cologne (W2 tenure track) and Giessen (W3).

Research Activity 3.3.: Ecosystem Services and Climate

[11.8 FTE Research and scientific services, 2.3 FTE Doctoral candidates]

The RA provides the societal component of Senckenberg's geobiodiversity framework. The mission is to provide knowledge of how society, climate and biodiversity interact and affect each other. Research focuses on how the analysis of social-ecological systems can guide decision-making for sustainable development. Key results cover advances in the quantification of ecosystem multifunctionality, identifying the role of human and wildlife mobility in promoting rangeland sustainability, or estimates on the effects of telecouplings on groundwater supply and biodiversity.

Other results aim at informing decision-making bodies, such as factors promoting human-wildlife coexistence, which are of relevance for the current recolonization of wolves in Germany. The RA engages not only in empirical research, but also in the development of concepts and methods relating to nature-society interactions. Here, the strategic cooperation with the Institute for Social-Ecological Research (ISOE) bridges gaps between natural and social sciences (interdisciplinary research) as well as between science and society (transdisciplinary research).

Between 2017 and 2019 the RA published 111 articles in peer-reviewed journals. The revenue from project grants totalled approx. 800 k€ (Ø 270 k€ p.a.), with 440 k€ spent from federal and *Länder* governments and 220 k€ from the DFG. In addition, 1.1 M€ have been raised from revenue from externally administered grants. In the same period, 5 doctoral degrees were completed.

Research Field IV: Biodiversity and Earth System Dynamics

Research Activity 4.1.: Evolving Earth and Environment

[18.8 FTE Research and scientific services, 2.9 FTE Doctoral candidates, and 3.9 FTE Service staff]

The RA studies past abiotic and biotic perturbations to the biosphere. The focus lies on the evolution of new forms and traits of organisms and on ecosystem regime shifts that followed deep-time disturbances or mass extinctions on land and in the oceans. The work aims at characterizing ecological disruptions affecting nature and humankind today and providing baselines and benchmarks for interpreting Anthropocene biodiversity loss from a past when humans were not a controlling factor.

Research is based on studies on the Holocene evolution of land- and seascapes in model regions such as the temperate North Sea and the tropical West African upwelling systems. The RA studies fossil lagerstätten as archives of past diversity and explores the composition and systemic interdependence of the biotic and abiotic world in deep time. The RA uses isotope geochronology and biostratigraphy to establish the timing of past disruptions against the ongoing 6th mass extinction.

Between 2017 and 2019 the RA published 327 articles in peer-reviewed journals. The revenue from project grants totalled approx. 2.4 M€ (Ø 800 k€ p.a.), with 1.3 M€ spent from federal and *Länder* governments and 490 k€ from the DFG. In the same period, 4 doctoral degrees and one habilitation were completed.

Research Activity 4.2.: Human Adaptation, Bio-Cultural Diversity and Ecology

[17.8 FTE Research and scientific services, 4 FTE Doctoral candidates, and 6.7 FTE Service staff]

The RA follows an interdisciplinary and integrative approach to explore how humans modified their environments in the past, and in turn how the environment influenced human biology, subsistence, cognition, and social behavior. The work aims at providing a long-term diachronic component of human biocultural evolution to understand human-environment interactions, tracing our own history to the beginning of the Anthropocene and beyond. The RA integrates research from working groups within SHEP, SF (including the Research Station at Weimar) and the Heidelberg Academy of Science project “The Role of Culture in Early Expansion of Humans” in Frankfurt and Tübingen. Research combines national and international archeological excavations with collection-based resources housed at SF (Frankfurt and Weimar) and SHEP. This also includes the Human Ethology Film Archive, with its cross-cultural diachronic database and international network.

The three key questions that guide research dovetail with the Senckenberg overarching research questions, including “How did the biotic and abiotic components of the Earth evolve from deep time to the present?” and “To what extent have ecosystem services already been exhausted and what could be solutions for a sustainable use of Earth’s resources?” A future goal is to establish a holistic framework for a systemic understanding of biocultural evolution that directly serves with its results other fields of science and the society given the modern threats imposed by pandemics and climate change.

Between 2017 and 2019 the RA published 206 articles in peer-reviewed journals. The revenue from project grants totalled approx. 570 k€ (Ø 190 k€ p.a.), with 260 k€ spent from federal and *Länder* governments and 150 k€ from the DFG. In addition, 4 M€ have been raised from revenue from externally administered grants. In the same period, 35 doctoral degrees and two habilitations were completed.

2. Program Research Infrastructure

[21.1 FTE Research and scientific services, 0.6 FTE Doctoral candidates, and 108.4 FTE Service staff]

The Program forms the backbone of the Senckenberg's activities. The Knowledge Resources (incl. collections, databases and libraries) are integrated across the Senckenberg institutes. Individual institutes establish, maintain, and develop their respective infrastructures, yet embedded in overarching concepts and structures. Integration is exemplarily shown by the collections, which are spread across all Senckenberg institutes. At approx. 40,000,000 collection units with an annual growth of about 250,000, Senckenberg runs Germany's largest natural history collections. Between 2017 and 2019 the collections were visited by 1,425 guest scientists. One major milestone since the last evaluation was the establishment of the new buildings in Frankfurt (see chapter 4). The available space for collections and associated research has increased from a total of 14,500 m² to 24,500 m² (plus the deep storage facility of 2,800 m²). Collection facilities are climate conditioned, and they are in close vicinity to improved labs and offices.

In reaction to a recommendation from the last evaluation, Senckenberg pushed forward the digitization of its collections. A working group on collections has been set up and has developed a collection and digitization concept. The digitization strategy prioritizes digitization of specimens that are in high demand (e.g. type specimens, species of difficult taxonomy), where high scientific input is needed to ensure the provided information is valid. Approx. 6,000,000 collection units are accessible in digital form (15 %). Between 2017 and 2019 the collection database has been accessed 460,000 times. Three in-house funded digitization projects in the fields of beetles, spiders and birds with a volume of 800 k € (2015-2018; plus one permanent collection development position) have been conducted.

This is amended by activities in externally funded projects. Senckenberg is member in several national research data infrastructures (NFDI) which are funded since 2020 by the federal and *Länder* governments and which bring multiple stakeholders together in a coordinated network of consortia to provide science-driven data services. Within the BMBF roadmap process for large German research infrastructures Senckenberg has developed since 2016 together with six other German natural history museums (lead institution: MfN Berlin) an application to establish a German virtual natural history collection (DCOLL). However, this initiative was not successful so far.

According to Senckenberg, without additional external funding it will not be possible to significantly speed up digitization. However, the European consortium "DiSSCo - Distributed System of Scientific Collections", of which Senckenberg is a core member, has been successful and is now funded by the European ESFRI program in the preparatory phase.

DiSSCo forms the center of a range of activities on the European level like “Synthesis for Systematic Resources” (SYNTHESSYS+), which creates an integrated infrastructure for natural history collections. DiSSCo is the European Research Infrastructure for natural science collections, under the umbrella of the European Strategy Forum on Research Infrastructures (ESFRI).

Senckenberg established a system of interlinked molecular laboratories, comprising small local labs for use by local researcher groups, while central labs with larger equipment serve the entire institution. Other facilities like genomics-technologies, high-performance isotope labs or imaging technologies are also core facilities across Senckenberg. Lab capacities in the field of genomics were extended with the new LOEWE centre TBG as a central pillar, amended by specialized facilities at several other local labs. A system of isotope labs was established across SHEP, SF and SNSD.

Furthermore, the Program is responsible for the operation of several research platforms including the three Senckenberg research stations in Hamburg, Messel and Schöningen, three observatories within the Long-Term Ecological Research (LTER) network (see chapter 6) and the research vessel. In reaction to a recommendation of the last evaluation, a new operating concept for the research vessel from 2021 was developed and plans for a long-term perspective were made based on a chartering concept, which includes the replacement of the old vessel by 2024. Between 2017 and 2019 the vessel was used 1584 person-days, including 318 person-days by external users (20 %).

Between 2017 and 2019 the revenue from project grants totalled approx. 3.6 M€ (Ø 1.2 M€ p.a.), with 2.6 M€ spent from federal and *Länder* governments and 480 k€ from the DFG.

3. Program Science & Society

[10.9 FTE Research and scientific services, 0.6 FTE Doctoral candidates, and 43.4 FTE Service staff]

To develop systemic solutions for the benefit of nature *and* people, the Science & Society program adopts an integrative, solution-oriented and participatory approach. In 2017 the Program Science & Society was restructured, developed and expanded. The three Senckenberg museums in Frankfurt, Dresden and Görlitz have a total permanent-exhibition space of approx. 6,800 m² and attracted between 2017 and 2019 on average 442,000 visitors per year (380,000 in Frankfurt). Since the last evaluation in 2013, Senckenberg has created nine touring exhibitions, reaching another 100,000 visitors per year. In addition, Senckenberg offers guided educational programs for on average 64,000 visitors per year. Senckenberg hosts 25 citizen science projects and collaborates with 1,750 registered citizen scientists and 170 volunteers.

The planned modernization and extension of the museum in Frankfurt is the top priority of the Program in the future. So far, a concept for the “New Natural History Museum Frankfurt” has been developed. It includes a complete structural upgrade of the entire museum, an extension building of about 7,000 m² as well as an exhibition and transfer concept. Supported by external funding and donations, the Program has tested new museum formats, including virtual and augmented reality applications and a digital media

guide. The first show rooms will open in September 2020 (“Deep sea” and “Marine Research”). The Program has also developed a participatory exhibition together with citizens (“Shaping the future - how do we want to live”) and cross-over exhibitions in collaboration with art institutions. Senckenberg is in dialog with the funding authorities exploring options to raise the necessary funds of about 360 M € for the realization of this project.

For public relations Senckenberg utilizes a variety of targeted communication instruments, ranging from social media, press work and short movies to publishing science books and articles, a science magazine “Natur-Forschung-Museum” (Nature-Research-Museum) and organizing public lecture series, resulting in almost 29,000 citations/year in the media and more than 30,000 followers/subscribers in various social media formats.

In terms of scientific counseling, Senckenberg engages with politics, administration, NGOs, companies and society. At the international level, Senckenberg contributes to the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IP-BES), the Intergovernmental Panel on Climate Change (IPCC), the International Union for Conservation of Natur (IUCN), and the UN World Ocean Assessment. At the national level, Senckenberg coordinates the Conservation Research Initiative of the BMBF (*Forschungsinitiative zum Erhalt der Artenvielfalt*), is responsible for a Statement of the National Academy Leopoldina on declines of species diversity and leads the Federal documentation and advisory office on the subject of the wolf.

Senckenberg also promotes knowledge and technology transfer (KTT). It uses various instruments to support the development of applications, resulting in a wide range of products including spin-offs. One example is the spin-off “Phytoprove”.

Between 2017 and 2019 the revenue from project grants totalled approx. 3.4 M€ (Ø 1.1 M€ p.a.), with 1.4 M€ spent from foundations, 800 k€ from federal and *Länder* governments and 620 k€ from the DFG.

8. Handling of recommendations from the previous evaluation

Senckenberg responded as follows to the 13 recommendations of the last external evaluation (highlighted in *italics*, see also statement of the Senate of the Leibniz Association issued on 17 July 2014):

*1. Senckenberg has accomplished the tasks associated with the major growth of the last four years very well. The new organizational structure is coherent and has largely been implemented. However, not all the organizational, administrative and content related processes that have been initiated to drive integration have been completed. As Senckenberg itself intends, it is particularly important to achieve in-depth consolidation. For this purpose, **the path that has already been adopted to integrated, crosslocational programmes should be rigorously pursued.** The operations at the **institute in Wilhelmshaven** which are mainly relevant for Research Activities 4 and 11 must be integrated considerably better than before.*

The Board of Directors has made consolidation after the strong growth phase in 2009 a central task. The statutes have been modernized and adapted. All administrative processes have

been improved, including implementation of SAP as management software. The Program Research has been reorganized so that all RAs are now supported by several institutes; the former RA 11 Marine (Bio-) Sedimentary Systems was abandoned so that now both divisions of Wilhelmshaven are integrated into several Research Activities. Similarly, the Senckenberg collections are organized in collection groups that link scientists across institutes and the same applies to the lab infrastructure and Science & Society Program with a joint Communication Board and regular meetings of the journal editors.

*2. A great deal of strategic thinking has gone into the key questions that have been elaborated for each Research Activity. This constitutes a major step. It is recommended to continue **refining the working and research programmes in the Research Activities** and, in particular, to continue developing their complementary focus.*

The research program was adapted in an organized process between 2018 and 2019 and Senckenberg developed its new strategic work plan 2020-2027 (see chapter 3).

*3. Senckenberg carries out its collection maintenance and development tasks very competently. The availability and accessibility of collection data on the other hand urgently needs to be improved. To achieve this, **digitization** is fundamental. Work on this considerable task is only progressing slowly. It is essential that it is stepped up vigorously.*

For results and plans regarding digitization see chapter 7 (Program Research Infrastructures).

*4. The permanent **exhibitions on offer in Frankfurt** fall below current museum standards and urgently require modernisation. This will allow Senckenberg to improve its public communication of science, further increase its number of visitors and thus retain its public visibility.*

For results and plans regarding the exhibitions see chapter 7 (Program Science & Society).

*5. Anchoring **BiK-F** within the framework of Senckenberg funding is essential both in terms of content and structure. It is positive that the Federation and the Land Hesse are seeking to continue financing the research centre, which is funded by the Land until 2014, within the framework of joint institutional funding.*

BiK-F has been integrated into Senckenberg in 2015 (see chapter 3).

*6. Collaboration with **groups at the University of Tübingen** in the context of Human Evolution and Paleoenvironment is also outstanding and of benefit to both parties. It is producing excellent scientific results and should be continued and intensified.*

The groups have been integrated as the new Senckenberg Centre for Human Evolution and Paleoenvironment (SHEP) in 2017 (see chapter 3).

*7. The plans presented to the Review board for the scientific use of a replacement for the **research cutter SENCKENBERG** were not convincing. No strategic priorities were articulated. It is recommended to search for alternative solutions and to coordinate the search intensively with the bodies responsible for German research vessels.*

A new operating concept for the research vessel was developed see chapter 7 (Program Research Infrastructures).

*8. The **infrastructure in Görlitz** was already judged to be unsatisfactory at the last evaluation. The Senate thus urged the Land Saxony to provide well-equipped facilities and laboratories for scientific work and to build a new, central, air-conditioned collection building. This has not happened so far. An improvement of the situation is thus urgently needed.*

The Federal government and the state of Saxony have agreed to finance a new institute building complex with 56 M €. Planning is in the final stages, completion of the overall construction project is planned for 2024.

*9. In order to enhance **international visibility**, Senckenberg should strive for more leadership roles in international bodies and international collaborative projects.*

Senckenberg made the following steps: Expansion of cooperation with international universities (e.g. Yale, Stanford, Ulan Bator). Organization of international Senckenberg conferences (e.g. Senckenberg Conference in Tbilisi 2016, "Geobiodiversity" in 2017, "Tibetan Plateau Research" in 2020). Development of an international alumni network at Senckenberg. International and internationally visible collaborative projects (e.g. DFG FOR Kilimanjaro, DFG SPP Biodiversity Exploratories, Central Asia projects in the "Third Pole Environment" (TPE) program, TPE office in Frankfurt, eLTER, DiSSCo). Participation in committees/institutions of political consultancy at national and international level (IPCC, IPBES, IUCN, UNEP, CITES, BfN, UBA, FutureEarth).

*10. Senckenberg must continue its efforts to increase the **proportion of women in scientific leadership positions**.*

Senckenberg implemented a tenure-track system through which 12 women have obtained permanent scientist positions since 2014. Senckenberg has now a full-time equal opportunities officer; recruiting guidelines require active targeting of women candidates, mentoring programs have been implemented, dual-career network established. Two out of five members of the Board of Directors are women (see chapter 5).

*11. Senckenberg has sites in seven Länder. The institution has managed to create a common scientific structure by implementing cross-locational programmes. But the funding is still based on the "Sitzlandprinzip" (i.e. the Land which hosts the respective institution provides for a higher percentage of funding). The Federal and Länder Governments must ensure that the Senckenberg management has the flexibility to set clear priorities (i.e. with consequences for the **distribution of funding across locations**).*

According to Senckenberg the "Sitzlandprinzip" cannot be changed for legal reasons, however various structures and processes have been developed to obtain more flexibility for the Senckenberg management. A structured process was established (*Länderklausur*) to intensify coordination among the federal and state governments. The General Administration was clearly separated from the budgets of the individual institutes to obtain more transparency. The Senckenberg Research Institute and Natural History Museum Frankfurt (SF) was separated from the General Directorate and became its own directorship to

clearly delineate central and institutional funding distribution. Resource allocation is annually discussed between the Board of Directors and the institutes. A consolidated “overhead” structure was put in place.

*12. Senckenberg has a **performance-related funding** policy based on publications in refereed journals and the acquisition of external funds. It is recommended to take account of the entire spectrum of activities in a research museum and also to reward achievement in the collections sector in particular.*

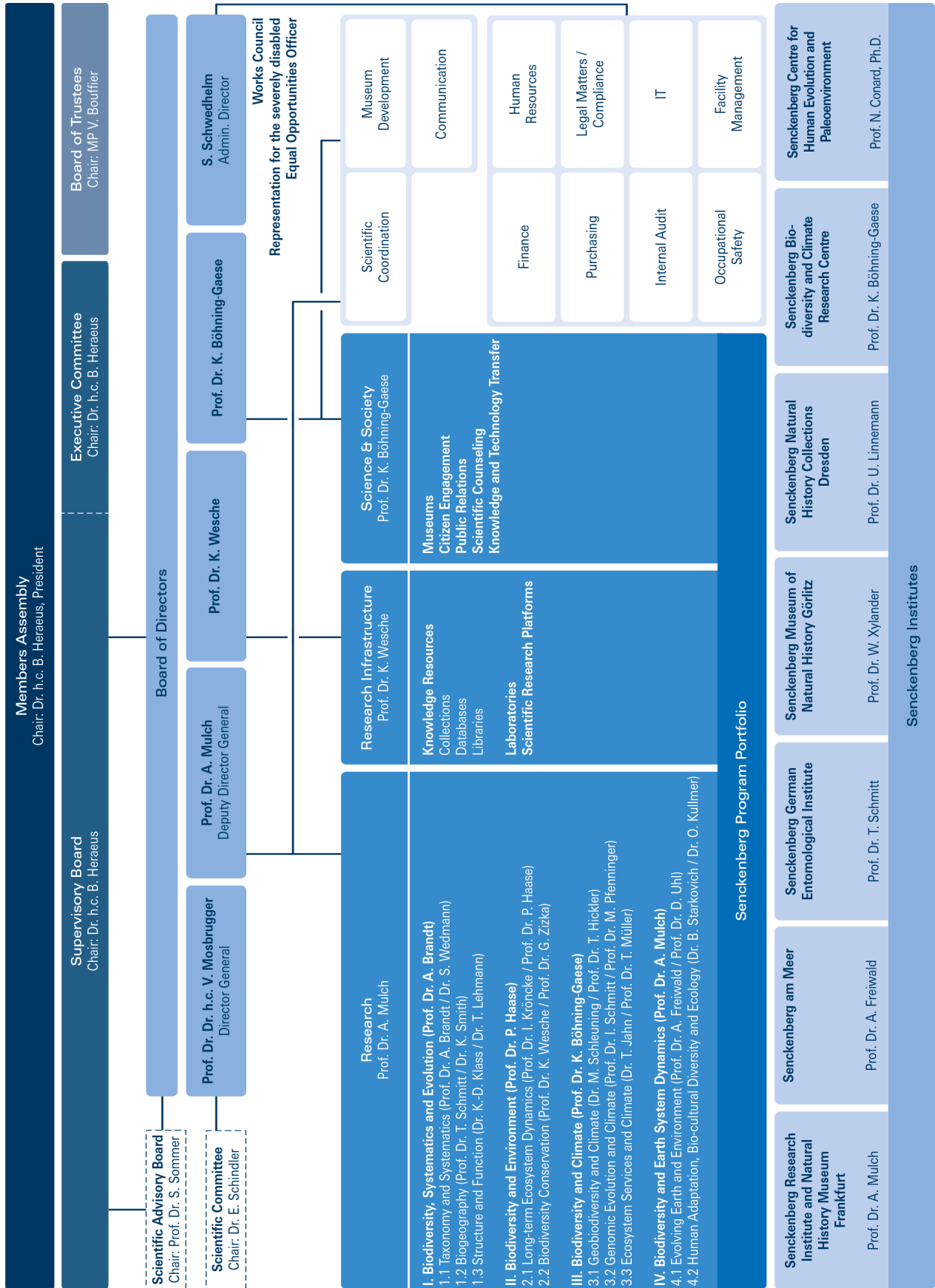
The Science & Society and Research Infrastructure Programs have been restructured and new target measures were implemented. A monitoring and reporting system has been established for the entire program portfolio. The performance-related rewarding strategy is now valid for all three Senckenberg Programs and includes the following components: financial incentives for the acquisition of external funds; competitive internally funded calls (e.g. for digitization); tenure track system considering excellent contributions to all three Senckenberg Programs; targeted fundraising for excellent projects in all three Senckenberg Programs.

*13. The **Scientific Advisory Board** is committed to its role but it should see its task more in terms of providing strategic advice. In general, the critical distance required of the Scientific Advisory Board should be more pronounced. To achieve this, the item in the statutes stating that membership of the Advisory Board should not exceed eight years should be implemented.*

The Statutes of the Scientific Advisory Board were revised, the Board was reduced in size and the legislative periods were shortened to the Leibniz standards of 4+4 years. A complete turnaround has taken place since the last evaluation.

Appendix 1

Organisational Chart



Appendix 2**Publications**

	2017	2018	2019
Total number of publications	794	947	837
Scientific books	11	11	10
Individual contributions to edited volumes	39	94	49
Articles in peer-reviewed journals (thereof ISI articles)	693 (602)	771 (657)	740 (639)
Articles in other journals	38	52	23
Work and discussion papers	13	19	15

Appendix 3 Revenue and Expenditure

Revenue		2017			2018			2019		
		k€	%	%	k€	%	%	k€	%	%
Total revenue (sum of I, II. and III.; excluding DFG fees)		86,254			99,925			74,703		
I.	Revenue (sum of I.1., I.2. and I.3)	55,105	100 %		60,131	100 %		63,719	100 %	
1.	Institutional funding	43,092	78 %		44,107	73 %		44,574	70 %	
1.1	Institutional funding by Federal and <i>Länder</i> governments	42,703			43,731			44,198		
1.2	Funding through the City of Frankfurt	389			376			376		
2.	Revenue from project grants	7,684	14 %	100 %	11,497	19 %	100 %	14,453	23%	100 %
2.1	DFG	3,461		45 %	3,665		32 %	5,159		36 %
2.2	Leibniz Association (competitive procedure)	391		5 %	760		7 %	406		3 %
2.3	Federal, <i>Länder</i> governments	2,680		35 %	4,886		42 %	6,019		41 %
2.4	EU	335		4 %	377		3 %	290		2 %
2.5	Foundations	515		7 %	690		6 %	1,013		7 %
2.6	Other sponsors	302		4 %	1,119		10 %	1,566		11 %
*	<i>Revenue from externally administered project grants</i>	2,115			2,287			4,668		
3.	Revenue from services	4,329	8 %		4,527	8 %		4,692	7 %	
3.1	Revenue commissioned work	1,586			1,606			1,797		
3.2	Revenue from publications	49			50			22		
3.3	Other services	2,694			2,871			2,873		
3.3.1	thereof museum revenue	1,957			2,210			2,416		
II.	Miscellaneous revenue	1,949			25,906			2,570		
1.	thereof membership fees	251			249			251		
2.	thereof donations	944			420			325		
3.	thereof rental income	37			41			50		
4.	thereof other	717			1,200			1,944		
5.	thereof sales proceeds building "Kuhwaldstrasse"				23,996					
III.	Revenue for construction projects (institutional funding by Federal and <i>Länder</i> govern., etc.)	29,200			13,888			8,414		

Expenditures		k€	k€	k€
Expenditures (excluding DFG fees)		86,254	99,925	74,703
1.	Personnel	36,425	37,176	40,007
2.	Material expenses	3,829	3,831	3,856
3.	Equipment investments	1,670	2,484	2,316
4.	Construction projects, acquisition of property	25,577	14,836	14,711
5.	Other operating expenses	18,753	41,598	13,813
5.1	thereof regular operating expenses	13,502	17,079	15,448
5.2	thereof forwarded to third parties from sales proceeds "Kuhwaldstrasse"		7,421	
5.3	thereof transfer into next fiscal year	5,251	17,098	-1,635
DFG fees (if paid for the institution – 2.5 % of revenue from institutional funding)		1,049	1,068	1,080

[*] additional line with externally administered project grants, are not included in sums, do not add up to %.

Appendix 4

Staff

(Basic financing and third-party funding / proportion of women (as of: 31 December 2019))

	Full-time equivalents		Employees		Female employees		Foreigners
	Total	on external funding	Total	on temporary contracts	Total	on temporary contracts	Total
	Number	Percent	Number	Percent	Number	Percent	Number
Research and scientific services	242.4	29.4	287	54.0	115	60.9	73
1st level (scientific directors)	8.0	0.0	8	0.0	1	0.0	1
2nd level (division leaders)	25.0	0.0	25	0.0	5	0.0	4
3rd level (group leaders or equi.)	79.9	2.5	86	8.1	32	3.1	5
Junior research group leaders	8	25.0	8	37.5	2	0.0	3
Scientists in non-executive positions	92.0	57.5	111	86.5	55	89.1	41
Doctoral candidates	29.5	49.0	49	100.0	20	100.0	19
Service positions	221.6	8.6	256				
Laboratory (E9 to E13)	62.7	7.70	68				
Laboratory (E5 to E8)	69.8	11.3	82				
Workshops (E9 to E11)	6.6	0.0	7				
Workshops (E2 to E8)	16.8	0.0	19				
Library	12.0	0.0	15				
Information technology - IT	23.3	8.6	24				
Museum (from E13)	7.6	47.4	9				
Museum (E9 to E12)	11.1	0.0	12				
Museum (E3 to E8)	11.8	5.9	20				
Administration	110.1	9.5	128				
Head of administration	1.0	0.0	1				
Staff positions (from E13)	14.1	17.8	19				
Staff positions (E6 to E12)	11.6	8.6	14				
Internal administration (from E13)	13.2	0.0	15				
Internal administration (E9-E12)	22.1	4.5	24				
Internal administration (E6-E8)	14.5	3.4	17				
Assistant and secretary (from E13)	5.4	14.2	6				
Assistant and secretary (E6-E12)	28.2	20.5	32				
Student assistants	41.3	23.0	152				
Trainees	37.6	8.0	38				
Scholarship recipients	10.0	40.0	10		6		5
Doctoral candidates	8.0	25.0	8		4		4
Postdoctoral researchers	2.0	100.0	2		2		1

Annex B: Evaluation Report

**Senckenberg Society for Nature Research -
Leibniz Institution for Biodiversity and Earth System Research,
Frankfurt am Main, Weimar, Wilhelmshaven, Hamburg,
Müncheberg, Dresden, Görlitz, Tübingen (SGN)**

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Appendix:

Members of review board

1. Summary and main recommendations

The Senckenberg Society for Nature Research (SGN) documents and analyses Earth system dynamics with a focus on biodiversity. In particular, it conducts research on and in nature, maintains and develops collections as ‘archives of nature’, and communicates research results to the general public, especially through museums. Senckenberg unites seven legally dependent research institutes and natural history museums in different *Länder*. All seven institutes contribute to one programme portfolio consisting of three *Programs: Research Infrastructure, Research, and Science & Society*.

The outcomes of the three *Programs* are for the most part extremely positive. With a total of approx. 40,000,000 collection units, Senckenberg is home to Germany’s largest natural history collections, which are some of the most important in the world. They form the basis for very good, in some cases excellent, research findings, which are regularly published in high-ranking journals with an international readership. In addition, the results are communicated successfully to a broader public, especially through exhibitions in the three museums in Frankfurt am Main, Dresden and Görlitz.

Senckenberg has expanded considerably since the last evaluation 2014. It had already grown significantly through the integration of three institutions in Müncheberg, Dresden and Görlitz in 2009. Since then, two more institutions have been added: in 2014 Senckenberg incorporated the Senckenberg Biodiversity and Climate Research Centre (SBIK-F), which was initially funded by the state of Hessen as a temporary research cluster. In 2017 it integrated the Senckenberg Centre for Human Evolution and Paleoenvironment (SHEP) at the University of Tübingen, with which it had previously collaborated very closely. In 2018, another major project was established: the LOEWE Translational Biodiversity Genomics Centre (LOEWE TBG), which is funded by the state of Hessen.

In the course of this massive institutional growth, the number of jointly appointed professorships rose from 3 (2006) to 17 (2013) to 30 (2020). Senckenberg now collaborates in this way with a total of nine universities. In parallel, Senckenberg realized a building programme with investments of approx. €229m. In the course of this, it implemented a comprehensive renovation and vitalisation project in Frankfurt to create more space for the collections, offices and laboratories (‘Masterplan I’). The sites in Weimar, Müncheberg and, in particular, Görlitz will also benefit once these plans are coming to reality.

Senckenberg has managed its significant expansion and increased institutional complexity remarkably well, in view of the large number of sites, institutes and stakeholders. Scientific output has increased, research infrastructure has been expanded considerably and important steps to improve knowledge transfer activities have been initiated and, in some cases, already implemented. Now the objective is to intensify and consolidate central tasks (see recommendation 5 below).

The General Director of Senckenberg has done an outstanding job since taking up the position in 2005. Under his leadership, the museum has become a globally visible research centre in the field of biodiversity research. His retirement on 31 December 2020 marks a major change for Senckenberg. It is very pleasing that the position has been filled again

seamlessly. The new General Director is a highly respected research figure with excellent connections in the scientific community as well as into science policy.

Special consideration should be given to the following main recommendations in the evaluation report (highlighted in **bold face** in the text):

Overall concept, activities and results (chapter 2)

1. The Senckenberg **collections** evolved under very different historic conditions and have only recently been brought together under one institution. This presents considerable challenges in terms of collection management. The great potential offered by consistent central management and development of the collections at the different sites should be exploited still more effectively over the coming years. The necessary structural decisions require not only close collaboration between the leading researchers, but also strong support from the boards, especially when crosslocational coordination involving different *Länder* is required.
2. **Digitising collections** is one of the main challenges faced by research museums worldwide. Senckenberg's current digitisation level of 15% is somewhat higher than at many other natural history museums in Germany. However, the interplay between collection development and research needs to be structured more systematically. To do so, the 'collectomics' concept developed by Senckenberg offers a starting point. A research-based digitisation concept must be set up as part of Senckenberg's overall strategy for all sites. This would also help make the collections more visible and accessible internationally. In addition, Senckenberg should investigate to what extent digitisation can be financed by a higher share of own funds, in addition to seeking third-party funding.
3. Classic taxonomic work is an important task for a research museum, and it should continue to be given a high priority as part of Senckenberg's coherent **publication strategy**.
4. The ongoing and urgent modernisation of the museum in Frankfurt is most welcome, but it is also essential to increase the attractiveness of the **permanent exhibitions** in Dresden and Görlitz. Senckenberg is expected to develop the concepts for its three important museum locations within a joint framework so as to make the most of the synergies targeted through the institutional merger and to increase visitor numbers.

Changes and planning (chapter 3)

5. With its 'geobiodiversity framework', Senckenberg has developed a coherent guiding idea for linking research work in the four *Research Fields* (divided into 10 *Research Activities*). However, in some cases, the contribution of the *Research Activities* to this central research strategy still needs further clarification and conceptual strengthening. In addition, there should be a special focus in the coming years on creating a stronger systematic link between the three central tasks – collection development, research and knowledge transfer. For the *Research Activities*, Senckenberg should clarify what contribution each one is expected to make to collection development as well as to knowledge transfer. This **consolidation of Senckenberg's existing tasks and structures** should be the focus of

the strategic development over the next few years, following its phase of rapid institutional growth.

6. The submitted plans to create a fifth **Research Field for Anthropocene Biodiversity Loss** by reallocating up to €2m are unconvincing. The scientific concept is too broad. And it is unclear what added value Senckenberg hopes to achieve above and beyond the existing *Research Activity 2.2 Biodiversity Conservation*, which is itself currently also too broad in scope (see chapter 7). In view of this lack of conceptual clarity in various areas, it is also not sufficiently clear what additional benefit the *Research Field* is intended to offer within the German and international research landscape.

Human resources (chapter 5)

7. The position of **Head of Administration** is currently vacant for the second time since the last evaluation. The way the seven Senckenberg institutes are spread over different *Länder* presents an enormous administrative challenge. It is very important for this position to be filled quickly and with an excellent candidate.
8. It is pleasing that the number of **female scientists** at the middle management level has increased significantly since the last evaluation. However, female scientists are still under-represented at the first and second management levels. Of the 17 new professorship appointments, six were made with women (35 %). Nevertheless, the proportion of women in scientific leadership positions must be increased further.

2. Overall concept, activities and results

Senckenberg's cross-locational overall concept is coherent. All seven Senckenberg institutes contribute to one programme portfolio consisting of the three *Programs: Research Infrastructure, Research, and Science & Society*. The activities and results of the three *Programs* are summarised below (for details on the *Program Research*, see chapter 7).

Program Research Infrastructure

This *Program* manages and develops Senckenberg's extensive research infrastructure facilities, which are highly valuable to the scientific community. They form an important basis for Senckenberg's own research work (*Program Research*) and for the knowledge transfer activities (*Program Science & Society*).

Senckenberg runs Germany's largest natural history collections, with currently approx. 40,000,000 units and an average annual growth of approx. 250,000 units. Between 2017 and 2019, the collections were visited by 1,425 guest scientists. In order to further promote external use, Senckenberg is a partner in the EU-funded network Synthesis for Systematic Resources (SYNTHESYS+), which creates an integrated infrastructure for natural history collections. The network is part of the Distributed System of Scientific Collections (DiSSCo), a European consortium of which Senckenberg is a core member. DiSSCo is funded by the European ESFRI programme in the preparatory phase.

The Senckenberg collections evolved under very different historic conditions and have only recently been brought together under one institution. This presents

considerable challenges in terms of collection management. The great potential offered by consistent central management and development of the collections at the different sites should be exploited still more effectively over the coming years. The necessary structural decisions require not only close collaboration between the leading researchers, but also strong support from the boards, especially when crosslocational coordination involving different *Länder* is required.

At the moment, approx. 6,000,000 collection units are accessible in digital form (15%). As expected, Senckenberg prioritizes digitisation of specimens that are in high scientific demand. Digitisation is primarily carried out through externally funded projects. Senckenberg is also involved in the DCOLL initiative.¹ Although this network is not currently being funded by the federal government as requested, it offers a very good platform for coordination between the seven participating museums. It is pleasing that Senckenberg is a member of several national research data infrastructures (NFDI), which have been funded since 2020 by the federal and *Länder* governments.

To improve internal and external valorisation of the collections, Senckenberg has developed a promising ‘collectomics’ approach. The aim is to expand the breadth of information that can be retrieved from the collections. This will involve artificial intelligence and new imaging methods, as well as genomics and state-of-the-art biogeochemical analyses. Implementation of this concept should also further strengthen the contribution of Senckenberg’s research work to the quantitative and qualitative development of the collections.

Digitising collections is one of the main challenges faced by research museums worldwide. Senckenberg’s current digitisation level of 15% is somewhat higher than at many other natural history museums in Germany. However, the interplay between collection development and research needs to be structured more systematically. To do so, the ‘collectomics’ concept developed by Senckenberg offers a starting point. A research-based digitisation concept must be set up as part of Senckenberg’s overall strategy for all sites. This would also help make the collections more visible and accessible internationally. In addition, Senckenberg should investigate to what extent digitisation can be financed by a higher share of own funds, in addition to seeking third-party funding. Alongside the collections, Senckenberg runs numerous laboratories, comprising smaller labs for local use and central labs with larger equipment that serve the entire institution and are open for international use. More recent developments that deserve a mention are the expansion of capacities in the field of genomics in the LOEWE Translational Biodiversity Genomics Centre (LOEWE TBG, see chapter 3) and the establishment of a multi-site system of isotope labs.

The *Program* also has a high level of experience in running several research platforms, including the three Senckenberg research stations (research station of the German Centre for Marine Biodiversity Research, and the two Fossil Pits in Messel and Schöningen), as

¹ DCOLL = *Deutsche Naturwissenschaftliche Sammlungen als integrierte Forschungsinfrastruktur* (German Natural Sciences Collections as an Integrated Research Infrastructure).

well as three observatories within the Long-Term Ecological Research (LTER) network.

In reaction to a critical comment in the last evaluation, Senckenberg developed a new concept for its research vessel and, as recommended, consulted with central German stakeholders in this field. The vessel will be sold to a private company at the end of 2020. In future, Senckenberg will secure use of a vessel for its North Sea research and monitoring activities via a charter contract. It plans to charter a new vessel from 2024 onwards.

Program Research (for a detailed assessment of the ten Research Activities, see chapter 7)

The *Program* is divided into four *Research Fields* (RFs) comprising ten *Research Activities* (RAs). This structure helps manage Senckenberg's scientific work across all locations. It was presented for the first time in the last evaluation and was assessed as being a suitable framework for the organisation's scientific development and coordination. Senckenberg has fleshed out the structure further over the past few years. The coherence of the work within the RAs has been increased, as recommended. However, the consolidation of the scientific work which had been expected is not yet complete because Senckenberg has grown again over the past seven years (see chapter 3).

The research results are mostly very good, in some cases excellent, and are published accordingly. In particular, the integration of the Senckenberg Biodiversity and Climate Research Centre (SBIK-F) and the Senckenberg Centre for Human Evolution and Palaeoenvironment (SHEP), both of which are strong in research, increased the proportion of publications in high-ranking international journals. In addition, the publication output in taxonomic journals continues to be very good. **Classic taxonomic work is an important task for a research museum, and it should continue to be given a high priority as part of Senckenberg's coherent publication strategy.**

Program Science & Society

Based on the research work and infrastructure (especially the collections), the *Program* elaborates various formats for transferring knowledge to society. Since the last evaluation, Senckenberg has restructured, developed and expanded the *Program* in a coherent manner.

The exhibitions are particularly important. Senckenberg runs permanent and special exhibitions in its museums in Frankfurt, Dresden and Görlitz. The last evaluation stated that the permanent exhibitions on offer in Frankfurt fell below current museum standards and were in urgent need of modernisation. Senckenberg had already recognised this and had initiated plans for improvements. To optimise implementation of the concept of a New Natural History Museum Frankfurt, Senckenberg plans further extensive construction measures over the long term (see chapter 4).

In view of the extensive modernisation work in Frankfurt, it was hardly avoidable that visitor numbers fell in recent years. At the last evaluation, the number of visits per year for the permanent exhibitions at all Senckenberg locations together was 540,000 (average 2010–2012). This figure is now only 442,000 (average 2017–2019). Total visitor numbers for the special exhibitions also fell.

Following the completion of first parts of a new permanent exhibition in Frankfurt in 2020, visitor numbers there should see a considerable increase after the end of the restrictions due to the pandemic. Increases also need to be achieved in Dresden and Görlitz. At the last evaluation, Senckenberg reported an increase in visitor numbers in Dresden following the 2009 integration. However, in 2017–2019, this figure had fallen back down to just approx. 25,000 visits per year on average. Görlitz is currently recording around 35,000 visits per year, which is also somewhat lower than in the previous reporting period. In October 2020, after considerable delays, major renovation and expansion works started in Görlitz. Visitor numbers should increase once these are complete in four years' time, if not before.

The ongoing and urgent modernisation of the museum in Frankfurt is most welcome, but it is also essential to increase the attractiveness of the permanent exhibitions in Dresden and Görlitz. Senckenberg is expected to develop the concepts for its three important museum locations within a joint framework so as to make the most of the synergies targeted through the institutional merger and to increase visitor numbers.

Through its *Program Science & Society*, Senckenberg is heavily involved in scientific counselling. It engages with policymakers, administration, NGOs, companies and society. At the international level, the *Program* makes significant contributions to e.g. the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) and the Intergovernmental Panel on Climate Change (IPCC). At the national level, the *Program* coordinates e.g. the Conservation Research Initiative of the BMBF (Forschungsinitiative zum Erhalt der Artenvielfalt) and leads the federal documentation and advisory office on wolves.

The *Program* is also responsible for Senckenberg's public relations. It uses a variety of targeted communication tools, ranging from social media, press relations activities and short movies to publishing science books and articles, a popular science magazine called Natur-Forschung-Museum (Nature-Research-Museum) and organising public lecture series. Senckenberg should seek to gain even greater visibility in the area of social media.

3. Changes and planning

Development since the previous evaluation

Senckenberg has once again expanded considerably since the last evaluation 2014. It had already grown significantly before the last evaluation. In 2009, Senckenberg absorbed the German Entomological Institute (DEI) in Müncheberg, the State Natural History Collections of Dresden (SNSD) and the Museum of Natural History in Görlitz (SMNG). Since then, two more facilities have been added: In 2014 it incorporated the Senckenberg Biodiversity and Climate Research Centre (SBiK-F), which had until then been fully funded by the state of Hessen as a temporary research cluster.² In 2017 it integrated the Senckenberg Centre for Human Evolution and Paleoenvironment (SHEP) at the University of Tübingen, with which

² As part of the Hessen's LOEWE programme (LandesOffensive zur Entwicklung Wissenschaftlich-ökonomischer Exzellenz – State initiative for the development of scientific and economic excellence).

it had previously collaborated very closely. In addition, another major project was established in 2018: the LOEWE Translational Biodiversity Genomics Centre (LOEWE TBG) with funding from the state of Hessen.

In the course of this massive institutional growth, the number of jointly appointed professorships rose from 3 (2006) to 17 (2013) to 30 (2020). Senckenberg now collaborates in this way with a total of nine universities. In parallel, Senckenberg realized a building programme with investments of approx. €229m. In the course of this, it implemented a comprehensive renovation and vitalisation project in Frankfurt to create more space for the collections, offices and laboratories ('Masterplan I'). The sites in Weimar, Müncheberg and, in particular, Görlitz will also benefit once these plans are coming to reality.

Senckenberg has managed its significant expansion and increased institutional complexity remarkably well, in view of the large number of sites, institutes and stakeholders. Scientific output has increased, research infrastructure has been expanded considerably and important steps to improve knowledge transfer activities have been initiated and, in some cases, already implemented. Now the objective is to intensify and consolidate central tasks.

Strategic work planning for the coming years

The General Director of Senckenberg has done an outstanding job since taking up the position in 2005. Under his leadership, the museum has become a globally visible research centre in the field of biodiversity research. His retirement on 31 December 2020 marks a major change for Senckenberg. It is very pleasing that the position has been filled again seamlessly. The new General Director is a highly respected research figure with excellent connections in the scientific community as well as into science policy.

With its 'geobiodiversity framework', Senckenberg has developed a coherent guiding idea for linking research work in the four *Research Fields* (divided into 10 *Research Activities*). However, in some cases, the contribution of the *Research Activities* to this central research strategy still needs further clarification and conceptual strengthening. In addition, there should be a special focus in the coming years on creating a stronger systematic link between the three central tasks – collection development, research and knowledge transfer. For the *Research Activities*, Senckenberg should clarify what contribution each one is expected to make to collection development as well as to knowledge transfer. This consolidation of Senckenberg's existing tasks and structures should be the focus of the strategic development over the next few years following its phase of rapid institutional growth.

The submitted plans to create a fifth *Research Field for Anthropocene Biodiversity Loss* by reallocating up to €2m are unconvincing. The scientific concept is too broad. And it is unclear what added value Senckenberg hopes to achieve above and beyond the existing *Research Activity 2.2 Biodiversity Conservation*, which is itself currently also too broad in scope (see chapter 7). In view of this lack of conceptual clarity in various areas, it is also not sufficiently clear what additional benefit the *Research Field* is intended to offer within the German and international research landscape. In conjunction with its plans for a fifth *Research Field*, Senckenberg is planning an expansion involving the addition of the Herbarium Haussknecht at the University of Jena. A proposal

was submitted to the Joint Science Conference of the German federal and *Länder* governments in August 2020 and will be evaluated in another procedure.

4. Controlling and quality management

Funding

The importance of the Senckenberg Society is highlighted by the fact that it receives considerable revenue from membership fees, donations or other sponsors (in 2019 approx. €2.5m). Senckenberg uses this revenue to finance a large proportion of its activities in Frankfurt, Dresden and Görlitz that relate to the operation of the museums.

In addition, all seven of the society's research institutes and natural history museums receive institutional funding from the federal and *Länder* governments (€44.2m). Further institutional funding came from the City of Frankfurt (€380,000). Institutional funding is adequate for the current range of tasks.

In addition, Senckenberg can point to impressive revenue from third-party funding for research projects and from its services. In 2019, these funds totalled €23.8m, corresponding to 35% of the overall budget. The revenue from project grants (including revenues from externally administered grants) totalled €19m (28%). In particular, Senckenberg managed to obtain funds through competitive procedures, e.g. from the DFG and ERC. From services (incl. museum tickets) Senckenberg generated revenue of €4.7m (7%).

Buildings

It is extremely positive to note that the federal government and the governments of the *Länder* in which the facilities are located finance Senckenberg's buildings and regularly extend or renovate them. The Senckenberg Society's civic engagement also deserves a mention.

In the 2013–2024 period, a total of €229m will be made available for a comprehensive infrastructure and building programme. In Frankfurt, the measures contained in 'Masterplan I' (€137m) and for the acquisition of an additional building (€22m) have already been implemented, as have measures in Weimar (€5m). Building improvements are to be completed in Müncheberg by 2022 (€9m) and in Görlitz by 2024 (€56m).

As outlined above, there is an urgent need for a further modernisation of Senckenberg's exhibitions. Senckenberg had already outlined ideas for a 'Masterplan II' at the last evaluation. These long-term ideas for a new museum building in Frankfurt are being pursued and are currently estimated at €360m.

Organisational and operational structure

Senckenberg's organisational structure is fit for purpose. It is managed by a 5-member Board of Directors, consisting of the Director General, an Administrative Director, and three other members, who manage the three Senckenberg *Programs*. The cross-locational structure of the *Programs* is an extremely important basic structure that makes a lot of sense. Its potential now needs to be exploited further (see chapter 3).

The funding bodies should make the most of their possibilities to support the integration of the institutes and locations that is expected from Senckenberg. The last evaluation criticised the fact that there was not enough flexibility for funds to be spent independently of individual locations. So, the fact that the challenging coordination among the federal and *Länder* governments has been improved through the introduction of a structured process based on a *Länderklausur* ('retreat') is welcomed.

Quality management

Senckenberg has the appropriate measures and structures in place for internal quality management. Rules for safeguarding good scientific practice have been implemented on the basis of the rules recommended by the DFG and later by the Leibniz Association. Senckenberg has an ombudsperson.

The quality management system comprises measures relating to indicators such as third-party revenues, publications and visitor numbers. For its internal performance appraisal and management, Senckenberg should set target values for these indicators (and for others, if applicable) and review them regularly.

Senckenberg follows the Guidelines on the Handling of Research Data within the Leibniz Association and is committed to the FAIR principles (findable, accessible, interoperable and reusable). In a welcome development, a new scientific coordinator was recently recruited to further develop and coordinate the processes across Senckenberg. The advice on dealing with and implementing the Nagoya Protocol makes sense.

Quality management by advisory board

The Scientific Advisory Board (SAB) performs its function as an external advisory body effectively. In 2018 it conducted the audit that is usually carried out for Leibniz institutions between two evaluations. The Supervisory Board (*Verwaltungsrat*) also performs its responsibilities well.

5. Human Resources

Management

Since the last evaluation, a number of management positions have been filled with extremely successful scientists. Senckenberg generally fills the positions of institute directors and division heads through joint professorial appointments based on cooperation agreements with universities. 17 of these joint appointments have been completed since the last evaluation. In summary, 30 Senckenberg employees hold W3/C4 or W2/C3 professorships at universities, and 9 employees hold extraordinary or honorary professorships.

The position of Head of Administration is currently vacant for the second time since the last evaluation. The way the seven Senckenberg institutes are spread over different *Länder* presents an enormous administrative challenge. It is very important for this position to be filled quickly and with an excellent candidate.

Postdoctoral staff

Senckenberg has good instruments in place for supporting postdoctoral staff. The various measures are well thought through and efficiently support career development.

Senckenberg has set up a very good tenure-track programme (three plus three years), which is based on a transparent catalogue of criteria. Since its establishment in 2014, 16 out of 22 candidates have been granted tenure after successfully completing the programme (73%).

Further evidence of the excellent scientific environment that Senckenberg offers emerging scientists can be seen in the fact that 20 postdoctoral researchers have been offered professorships or leading positions at other institutions since the last evaluation. In addition, 11 employees successfully completed their habilitation.

Doctoral candidates

Senckenberg is an attractive location for doctoral researchers and places are in high demand. As of 31 December 2019, there were 57 PhD candidates working at Senckenberg (including 8 scholarship recipients). Additionally, Senckenberg employed numerous externally supervised doctoral researchers. Between 2017 and 2019, 114 doctoral candidates at Senckenberg successfully completed their PhD degrees.

All doctoral candidates are eligible to participate in structured doctoral programmes, e.g. the GRADUATE Academy run by TU Dresden, GRADE - the Goethe Research Academy for early-career researchers at Goethe University in Frankfurt, or OLTECH at the University of Oldenburg. The latter also offer specialised programmes that are adapted to the topics of interest to Senckenberg.

Non-scientific staff

Senckenberg runs a state-certified school for museum technicians, where scientists and technicians impart knowledge and skills in science-supporting activities. Through this, Senckenberg plays an important role in training staff who are in high demand at natural history museums and other research institutes. In addition, since the last evaluation, vocational training courses have been offered and completed for office management assistants and specialists in media and information services.

Senckenberg supports employees who are continuing their education in extra-occupational courses of study, and offers the opportunity for professional orientation and qualification. The museums in Frankfurt am Main, Görlitz and Dresden offer traineeships (*Volontariate*), in which university graduates become acquainted with all fields of activity relevant to the operation of a museum.

Equal opportunities and work-life balance

Of the nearly 300 scientific staff, 40% are currently women, the same proportion as seven years ago. In 2013 there were 18 scientific management positions (levels 1 and 2), of which 4 (22%) were occupied by women. Now there are 33 positions at this level, of which 6 (18%) are occupied by women. The number of research group and junior research group

leadership positions rose from 18 to 94. The proportion occupied by women rose considerably, from 3 (17%) to 34 (36%).

It is pleasing that the number of female scientists at the middle management level has increased significantly since the last evaluation. However, female scientists are still under-represented at the first and second management levels. Of the 17 new professorship appointments, six were made with women (35 %). Nevertheless, the proportion of women in scientific leadership positions must be increased further.

Work-life balance

The measures to support a work-life balance appear effective. In 2012, Senckenberg was certified by the 'berufundfamilie' audit. It was successfully recertified in 2016 and 2019.

6. Cooperation and environment

Cooperation with universities

Senckenberg collaborates outstandingly well with local and regional universities at its various locations through joint professorial appointments, the training and promotion of doctoral students, joint scientific endeavours and academic teaching. The most comprehensive partnerships are with the three universities in Frankfurt am Main, Tübingen and Dresden.

Senckenberg's good relationships with universities can also be seen in various DFG-funded joint projects in which it has been involved since 2013. These include two Clusters of Excellence, one Research Centre, one Collaborative Research Centre, eleven DFG Research Units, nine DFG Priority Programmes and two DFG Research Training Groups.

Senckenberg employees make a significant contribution to teaching at the partner universities. Each semester, approximately 70 Senckenberg scientists teach around 300 hours per week, covering the fields of biology, geology, palaeontology, crystallography, meteorology, prehistory, palaeoanthropology and geography.

Cooperation with non-university partners

The Institute for Social-Ecological Research (ISOE) is Senckenberg's most important partner among the non-university institutes. ISOE is particularly closely involved in the work of *RA 3.3 Ecosystem Services and Climate*. The Director of ISOE is one of two coordinators of this RA. Against this background, the pending vacancy (due to retirement) at the head of ISOE is of high significance for Senckenberg.

Senckenberg is also very well connected within the Leibniz Association. Besides its involvement in individual joint projects, Senckenberg is a member of two Leibniz Research Alliances and three Leibniz Research Networks. Its collaboration and coordination with the seven other research museums within the Leibniz Association is of particular relevance. The Senckenberg General Director is the spokesperson for the network of the Leibniz Research Museums. It is suggested to collaborate with the other two natural history museums in the association, the Museum für Naturkunde (MfN) and the Leibniz Institute for the Analysis of

Biodiversity Evolution (L.I.B.).³ In the area of outreach, joint activities are encouraged since 2017 through the BMBF-funded Action Plan of the Leibniz Research Museums. In research, coordination should be increased.

Senckenberg is also a partner in the DCOLL initiative⁴ consortium, which brings together seven partner institutions, including four Leibniz institutes. It aims to mobilise, structure, interlink and make openly available data hidden in natural science collections in Germany. It is good to see that the joint activities are being continued despite the failed application for the German National Roadmap for Research Infrastructures.

In view of the establishment of the new LOEWE Translational Biodiversity Genomics Centre (LOEWE TBG, see chapter 3), Senckenberg should also now consider strategic partnerships in the field of genomics or coordinate with the institutions that are active in this field in Germany.

International collaborations

Senckenberg is very well connected internationally and is involved in a large number of networks, groups and consortiums. And it is increasingly taking on lead roles, as recommended in 2013. For example, Senckenberg is a member of the Consortium of European Taxonomic Facilities (CETAF), has a lead role in the preparation of the Distributed System of Scientific Collections (DiSSCo) involving more than 110 different institutions, and in the pan-European network Synthesis for Systematic Resources (SYNTHEsys+). Its involvement in numerous Long-Term Ecological Research (LTER) activities at national and international level also deserves a mention.

Senckenberg has important collaborative relationships outside of Europe with e.g. the Institute of Tibetan Plateau Research, with which it collaborates in the international Third Pole Environment (TPE) programme, which studies the role of the Tibetan Plateau under Anthropocene climate change. Senckenberg also maintains long-standing relationships in some West African countries. Recent activities also include the study of biodiversity and social ecological systems in Tanzania within the DFG-funded Research Unit 'The role of nature for human well-being in the Kilimanjaro Social-Ecological System'.

³ Up until 31 December 2020 this was two separate institutions: ZFMK Bonn and Centre of Natural History (CeNak) in Hamburg.

⁴ DCOLL = Deutsche Naturwissenschaftliche Sammlungen als integrierte Forschungsinfrastruktur (German Natural Sciences Collections as an Integrated Research Infrastructure)

7. Subdivisions of SGN

Program Research Infrastructure

[21.1 FTE research and scientific services staff, 0.6 FTE doctoral candidates and 108.4 FTE service staff]

See chapter 2.

Program Science & Society

[10.9 FTE research and scientific services staff, 0.6 FTE doctoral candidates and 43.4 FTE service staff]

See chapter 2.

Program Research

Research Field I: Biodiversity, Systematics and Evolution

Research Activity 1.1: Taxonomy and Systematics

[36.4 FTE research and scientific services staff, 6.2 FTE doctoral candidates and 8.7 FTE service staff]

This biggest *Research Activity* (RA) generates fundamental museum-specific research work, exploiting and classifying the collections – work that is of central importance for the SGN as a whole. The RA comprises recent and fossil biodiversity of a very broad variety of organisms (plants, metazoa, fungi, dinoflagellates) in many habitats or regions (worldwide including deep sea) and geological eras (including palaeontology). The RA makes use of a broad spectrum of taxonomic and molecular methods (morphology, genetics, genomics, proteomics and bioacoustics) that are constantly being developed further. The integration of the LOEWE Translational Biodiversity Genomics Centre (LOEWE TBG) means advanced methods like high-throughput sequencing are now being used as well, expanding the integrative taxonomy approach at the highest level. Based on the extensive collections, 1,267 new species and subspecies, 153 genera, ten families and – a very rare discovery – one new insect order (Alienoptera) have been described since the last evaluation. The RA is also very successful at including citizen science activities in its work.

The RA has a coherent strategy for the publication of research findings. On the one hand, the more descriptive papers are published in classic taxonomic journals, enhanced by state-of-the-art illustrations using laser scanning confocal microscopy (LSCM) or by the provision of sequence data. On the other hand, excellent cutting-edge results (e.g. the work on baleen whale evolution) are published in high-ranking journals. As recommended during the last evaluation, the number of publications in high-ranking journals has been increased. It is also worth noting that around half of all publications are generated in collaboration with other RAs, confirming the central position of the RA. Besides journal articles, the RA also makes use of various other formats to disseminate research results, including monographs, edited volumes, internet portals and databases.

The RA can point to various revenues from third-party funding (project grants and commissioned work), which have increased further in recent years. They include funds obtained through competitive procedures, e.g. from the DFG. It is also positive that the RA is heavily involved in training early-career scientists. It makes sense to further intensify collection-based research in the future, in line with the collectomics concept, on the basis of the expanded DNA and tissue collections, and to involve high-throughput sequencing methods and various novel imaging techniques.

Research Activity 1.2.: Biogeography

[12.5 FTE research and scientific services staff, 1.4 FTE doctoral candidates and 2.2 FTE service staff]

The RA studies most of the major organismic groups in terrestrial, limnic and marine environments in almost all regions of the world. Since the last evaluation, it has intensified the inclusion of paleontological research in biogeography and has enhanced capacities in using genetic methods (e.g. genomics and next-generation sequencing). The individual projects are very good but sometimes there is hardly any connection between them. Although the RA has defined two thematic focus areas – the marine environment and the Qinghai-Tibet Plateau – these are too broad and much work in the RA is not connected to these areas.

The RA publishes a large proportion of its results in taxonomic journals, but also regularly publishes in leading journals of biogeography. The molecular biogeography textbook is an important output and the work on *Mnemiopsis* is an elegant demonstration of the power of molecular tools in this field. The RA successfully acquires funds from project grants. The increase in funds from competitive DFG procedures is a welcome achievement.

As part of the collectomics approach, the RA plans to further intensify the analysis of old collection material through increased use of advanced analytical methods, especially in genetics and modelling. This will facilitate very interesting new insights. In order to increase the coherence of the activities and effectively integrate the employees at the various locations who are involved in RA 1.2, the staffing structure should be reviewed. There are currently 60 people involved in the RA, but frequently only for a very small proportion of their working hours. This is another factor that makes it difficult to give the RA a clear focus and differentiate it in terms of subject matter from RA 1.1.

Research Activity 1.3.: Structure and Function

[11.5 FTE research and scientific services staff, 1.3 FTE doctoral candidates and 1 FTE service staff]

The RA is very successful at studying organismic structures and their functions, with the aim of understanding how organisms like plants, insects, bryozoans or vertebrates function and interact with their environment, and transferring organismic functions into applications. Overall, the research is topical, advanced and relies on cutting-edge technologies. The basis for the innovative research work is the collections, including extensive morphological databases (collectomics). The RA uses a broad variety of methods (e.g. biomechanics, occlusal fingerprint analysis and skeletal ultrastructure). One core competence of RA 1.3 is

its largely collection-based morphological study of extant and extinct organisms. An emerging second core competence is in the field of genomic studies, mainly through the new LOEWE TBG. Although a large number of projects are carried out, the RA has a clearly discernible profile and fits very well into Senckenberg's geobiodiversity framework.

Its publication output is very good and the research results are internationally recognised. Many papers are produced in collaboration with other RAs. Besides journal articles, the RA also produces monographs, edited volumes and records in public databases (e.g. the MaTrics database). The RA successfully raises third-party funding, although this is almost entirely within the competitive procedure of the Leibniz Association. The RA should make use of the very good opportunities it has to acquire funding from the DFG or EU as well. The RA is heavily involved in training early-career scientists. Its plans for the future make sense. Among other things, it plans to increase databasing of morphological traits and to further develop genomic research (genotype/phenotype).

Research Field II: Biodiversity and Environment

Research Activity 2.1: Long-term Ecosystem Dynamics

[11.2 FTE research and scientific services staff, 0.8 FTE doctoral candidates and 6.3 FTE service staff]

The RA 2.1 is pursuing a mission of generating and analysing systemic long-term (approx. 10-100 years) biodiversity and environmental data and trends. The focus of its work is on running four observatories in marine, limnic and terrestrial ecosystems (Rhine-Main Observatory, North Sea Benthos Observatory, Frankfurt City Biotope Observatory, DFG Biodiversity Exploratories), which are part of the national Long-Term Ecological Research (LTER) network. In this way, Senckenberg also makes a significant contribution to the European eLTER consortium.

On the basis of data it has collected itself and data from other sources, the RA successfully generates highly visible research results on long-term biodiversity change within Europe and worldwide. The publication output has been improved since the last evaluation and the RA now regularly manages to publish in high-impact scientific journals. Third-party funding revenues are high and comprise a significant proportion of DFG grants. EU-level funding should be increased. In addition, analysis of the extensive and valuable data should make it possible to increase the number of doctorates completed in the RA.

Further development of the RA should strengthen the social-ecological research area, as planned. The data collected in the LTER observatories are of high relevance for society and politics, and the RA has the potential to become an important, highly visible hub of expert knowledge on Anthropocene environmental change. In future, therefore, it should continue to play a leading role in the German and European LTER network and contribute to its strategic development, e.g. regarding the setting up of additional observatories.

Research Activity 2.2. Biodiversity Conservation

[19.7 FTE research and scientific services staff, 4.4 FTE doctoral candidates and 4.2 FTE service staff]

The RA runs highly application-oriented projects with the aim of developing methods and strategies that help implement national and international environmental regulations. Among other things, it runs important studies on genetic wildlife monitoring. These are used for wolf management by the Central European Wolf (CEwolf) consortium, which aims to harmonise research on wolf genetics across Europe. A more recent project involves conservation action and monitoring in the Biosphere Reserve Upper Lusatian Heath and Pond Landscape. The varied projects are very interesting in themselves but at times there is not much of a link between them and / or to the Senckenberg-collections.

The research findings are important because of their practical relevance and are internationally recognised. The publication output is constantly good. Knowledge transfer to political decision-makers works well and is evident in a high and increasing number of expert reviews. Revenues from project grants are high, but come almost exclusively from the United Nations Environment Programme (UNEP) or from the federal and *Länder* governments. The portfolio of funding sources should be diversified. In addition, the RA has generated high revenue from commissioned work.

RA 2.2 should develop its own clearly discernible profile and improve internal coherence. This should then also be reflected in a more sharply defined name for the RA.

Research Field III: Biodiversity and Climate

Research Activity 3.1.: Geobiodiversity and Climate

[24.4 FTE research and scientific services staff, 10.8 FTE doctoral candidates and 0.3 FTE service staff]

The RA generates outstanding results in the field of geobiodiversity research, contributing to a better understanding of the functional role of biodiversity in ecosystems. Much of the innovative work is supported by the Senckenberg Biodiversity and Climate Research Centre (SBIK-F), which was integrated in 2014. Within this extremely effective, fruitful and integrated approach, empirical studies are combined with modelling and with geoscience and bioscience methods. This makes it possible to learn from the geological past and to make better predictions about future changes to biodiversity. The RA runs two important research infrastructure facilities: the Joint Goethe University-Senckenberg BiK-F Stable Isotope Facility and the Senckenberg Data and Modelling Centre.

The publication output is excellent in terms of both quality and quantity. Third-party funding revenue is very high, with the vast majority being acquired through the competitive DFG procedures. The RA's high involvement in training early-career scientists is also welcomed. The number of doctorates completed is very high.

The RA follows a unique systemic and holistic approach, integrating Senckenberg's geological and palaeontological records. It should therefore play a greater role in the further development of the collection strategy. For example, the RA could provide guidance on how

future collecting could provide insights on impacts of climate on evolutionary or biodiversity changes.

Research Activity 3.2.: Genomic Evolution and Climate

[10.5 FTE research and scientific services staff, 2.3 FTE doctoral candidates and 1.5 FTE service staff]

The RA successfully investigates the impact of climate on the evolution of genomes. The RA uses present genomic diversity to infer past evolutionary processes, and to extrapolate future developments. It integrates methodological approaches from genomics and molecular biology, data science and bioinformatics, in combination with field and laboratory experiments. Experimental work is mostly performed in the Mesocosm Hall, a state-of-the-art experimental infrastructure with climate chambers and terrestrial mesocosm facilities that can simulate a wide range of climate conditions.

Research results that deserve highlighting include those relating to links between ploidy levels of plants and their habitat (e.g. temperature and altitude). The publication output is very good and the RA regularly attracts project grants. A large proportion of grant funding comes from the federal and *Länder* governments. The successful acquisition of funds from the state of Hessen to set up the LOEWE Translational Biodiversity Genomics Centre (LOEWE TBG) deserves a special mention. This will significantly improve the translation of knowledge acquired in genomic research into practical applications. Excellent scientists have already been recruited to fill leadership positions at the LOEWE TBG. For the future, the RA should strive to diversify its third-party funding portfolio.

Research Activity 3.3.: Ecosystem Services and Climate

[11.8 FTE research and scientific services staff, 2.3 FTE doctoral candidates]

The RA pursues a challenging mission: to provide knowledge of how society, climate and biodiversity interact and affect each other. Research focuses on the analysis of social-ecological systems, with the aim of guiding decision-making for sustainable development. The RA successfully engages not only in empirical research, but also in the development of concepts and methods relating to nature-society interactions. Here, the strategic cooperation with the Institute for Social-Ecological Research (ISOE) bridges gaps between natural and social sciences (interdisciplinary research) as well as between science and society (transdisciplinary research).

The research results are very good and cover advances in the quantification of ecosystem multifunctionality, the role of human and wildlife mobility in promoting rangeland sustainability, and estimates of the effects of telecouplings on groundwater supply and biodiversity. Other results aim to provide decision-making bodies with relevant information, such as factors promoting human-wildlife coexistence, which are of relevance for the current recolonisation of wolves in Germany. The publication output is very good. The RA successfully acquires third-party funding, in particular through the BMBF procedures that have strong links to societal issues. The RA should obtain other sources of funding in future.

Having managed to attract some very good scientists for the RA's projects, the upcoming appointment of a director at the ISOE will be of central importance for the RA's further development. The objectives should be to further sharpen the RA's profile with a more clearly defined guiding theme. In addition, target values should be defined and monitored for the internal assessment of the research-based transfer work.

Research Field IV: Biodiversity and Earth System Dynamics

Research Activity 4.1.: Evolving Earth and Environment

[18.8 FTE research and scientific services staff, 2.9 FTE doctoral candidates and 3.9 FTE service staff]

The RA is very successful in researching the interactions between geodynamic processes and the development of life on Earth. Its projects range from the Precambrian to recent times. It uses a wide range of innovative methodological and analytical approaches, and makes excellent use of the palaeontological collections, supplemented by targeted field research. The Messel Pit Fossil Site, in particular, which is a UNESCO world heritage site, represents an extraordinary resource. In response to a recommendation in the last evaluation, another RA that was not well performing has been integrated into this one, and the whole RA has been effectively restructured. As well as terrestrial environments, research now also covers marine environments, such as the temperate North Sea and the tropical West African upwelling systems.

Excellent research results relate to e.g. triggers for mass extinction, the evolution of biota and fossil Lagerstätten as archives of past diversity. The publication output is very good and the RA regularly publishes in very high-ranking journals. The RA successfully acquires third-party funding, including from the DFG.

When it comes to future development, the RA needs to keep an eye on the coherence of projects. In the area of palaeontology, it could be worth strengthening work on deep time (Mesozoic and Palaeozoic). A combination of taxonomic studies and meta-analyses appears promising here. In addition, the RA should establish more clearly how research results are transferred to society. Collaboration with the Museum of the University of Tübingen could be of interest here.

Research Activity 4.2.: Human Adaptation, Bio-Cultural Diversity and Ecology

[17.8 FTE research and scientific services staff, 4 FTE doctoral candidates and 6.7 FTE service staff]

The RA uses innovative methods from archaeological, palaeontological, and palaeoanthropological research and fieldwork to study which environmental parameters influence human biology, behaviour, and cognition. The research work, which was already found to be outstanding in the last evaluation, has been further enhanced through the integration of the Senckenberg Centre for Human Evolution and Palaeoenvironment (SHEP) in Tübingen, with which the RA cooperated very closely in the past. The fieldwork includes long-term and highly prominent sites (e.g. Malawi and Schoeningen) and is complemented by a good use of the collections and by 3D morphometry imaging techniques. The RA

collaborates with the Museum of the University of Tübingen and contributes to the maintenance of its collections. The Human Ethology Film Archive, which the RA took over in 2014, is another valuable facility.

The research results are excellent. Research studies worth highlighting relate to hominin dietary versatility, the earliest evidence of *Homo sapiens* in Europe, and the earliest culturally modern behaviour in Europe. The publication output is outstanding, in terms of both quality and quantity. Third-party funding revenue is very high and includes funds acquired through competitive procedures run by the DFG and the ERC (a large proportion of this funding is administered by the University of Tübingen). In addition, shortly after the evaluation, a female scientist working in this RA won the Leibniz Prize, the top German research prize, awarded by the DFG. The RA is also very successful when it comes to training emerging scientists. As well as a very high number of completed doctorates, two post-doctoral habilitations were also successfully completed.

In order to further strengthen the already very good transfer of the RA's excellent research findings, priorities should be set in this area for the future.

8. Handling of recommendations of the last external evaluation

SGN successfully addressed the recommendations made by the Leibniz Association Senate in 2014 (see Status Report, pp. A-28).

Appendix

List of Participants

1. Review Board

Chair (Member of the Leibniz Senate Evaluation Committee)

Konrad Fiedler Department of Botany and Biodiversity
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Animal Biodiversity, University of Vienna

Deputy Chair (Member of the Leibniz Senate Evaluation Committee)

Volker Rodekamp Museum of the City of Leipzig

Reviewers

Dirk Albach Institute of Biology and Environmental
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Elisabeth Haring Natural History Museum Vienna, AUT

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Ute Radespiel University of Veterinary Medicine Hannover,
Foundation

Representative of the Federal Government

Anna Seulen Federal Ministry of Education and Research,
Bonn

Representative of the Länder Governments (Member of the Leibniz Senate Evaluation Committee)

Marc Brüser Ministry of Science, Education and Culture of
Rhineland-Palatinate

17 March 2021

Annex C: Statement of the Institution on the Evaluation Report

**Senckenberg Society for Nature Research -
Leibniz Institution for Biodiversity and Earth System Research,
Frankfurt am Main, Weimar, Wilhelmshaven, Hamburg,
Müncheberg, Dresden, Görlitz, Tübingen (SGN)**

Senckenberg is grateful to the Leibniz Association and the esteemed review panel members for conducting a thoughtful and fair evaluation. Unfortunately, the members of the review panel were not able to visit Senckenberg due to the Corona pandemic. We consider this limitation a very regrettable fact.

Senckenberg appreciates the overall outcome of the evaluation. The assessment of the review panel confirms that the quality and relevance of Senckenberg's Earth System approach that encompasses research, infrastructure development and transfer activities meets very high to highest standards at international levels. Concurrently, the panel report underlines the major progress Senckenberg has achieved during the past years, in particular through the successful integration of two new institutes as well as the continuous implementation and advancement of a coherent Geobiodiversity framework, which is considered unique among the institutions of the Leibniz Association and beyond. Senckenberg has successfully managed a comprehensive renovation and vitalization program of its research, office and collection buildings, in particular in Frankfurt (Masterplan I) as emphasized in the evaluation report. Following the advice of the panel we will continue our efforts in advancing the New Senckenberg Museum Frankfurt to establish a globally visible museum platform for research, public dialogue and knowledge exchange that is on par with our research efforts.

Senckenberg greatly appreciates the recommendations made by the panel members and will thoroughly implement these in the coming years. We are very grateful that the review panel highlights the multitude of opportunities of our *Collectomics* efforts and encourages us to move forward in this direction. Furthermore, the continuation of our efforts in Translational Biodiversity Genomics is considered indispensable in expanding and advancing biodiversity research, at highest international levels, and in fully exploiting the information and knowledge embedded in Senckenberg's globally unique collection materials.

We identify a few comments where our perspective differs from that of the reviewers, likely because aspects of the information provided in the documents and during the two-hour evaluation may have been too brief and therefore potentially misleading.

- The assessment of a planned strategic item of expenditure "Anthropocene Biodiversity Loss" was never part of this evaluation. We are hence surprised that its overall scope and architecture was critically addressed, in particular as cornerstones of this proposal such as *Collectomics* and biodiversity genomics received very favorable mention in the evaluation report.
- We concur with the panel that museum development is a continuous effort to adapt to changing visitor expectations while at the same time to provide access to state-of-the-art research. However, we would like to reiterate that the building program in Görlitz explicitly excludes the museum but rather focuses on new collection, office and laboratory infrastructure. It would hence be unrealistic to expect a visitor increase as a consequence of this building program.

Finally, we would like to express our sincere thanks to everyone supporting Senckenberg in its endeavor and ambitions, including a dedicated supervisory board, a committed inter-

national scientific advisory board, and more than 7,000 active members of the civic society. Most of all, we are extremely proud of our dedicated and competent Senckenberg staff. The very positive outcome of the evaluation will be a further boost for everyone at Senckenberg to serve as a pioneer and role model in investigating and understanding the fundamental role of biodiversity in the Earth system, as well as its importance in developing systemic solutions for a sustainable relationship between nature and people for future generations.