EXHIBITION TEXTS

Bending the Curve – Knowing, Acting, Caring for Biodiversity

13.10.2023 — 03.03.2024

Ground Floor

Max Planck Institute of Animation Behavior, Department of Migration

Headed by Prof. Dr. Martin Wikelski
and team
ICARUS (Uschi Müller & team)
Schäuffelhut & Berger GmbH, Movebank
Babette Eid & team, MPIAB, MaxCine
couchbits GmbH, Michael Quetting, MPIAB, Movebank Museum and AnimalTracker
Dr. Kamran Safi, Dr. Andrea Kölzsch, Dr. Anne Scharf, MPIAB, MoveApps
Carla Avolio, MPIAB, Press and Outreach

Movebank
Two videos, 3D animations
3 min; 1:30 min

ICARUS Basic tag - Wearable for wildlife
Solar-powered, for tracking of acquiring position and velocity, 3D-acceleration, magnetic field vector and temperature.
Plastic
4,5 – 5 g

Courtesy Max-Planck-Institut für Verhaltensbiologie, Rohde & Schwarz INRADIOS GmbH, TALOS GmbH

Movebank is an open-source platform developed by the Max Planck Institute of Animal Behavior in collaboration with the North Carolina Museum of Natural Sciences, Ohio State University, and the University of Konstanz. The platform assists scientists and wildlife managers worldwide in collecting, managing, sharing, analyzing, and archiving billions of animal movement data and other data-based information relating to animals. Movement data contribute to creating knowledge and understanding of how animals live, how they respond to the growing impact of humans, and how they influence commonly inhabited ecosystems.

Where are animals moving, and why? How does animal behavior affect the ecosystem, and vice versa? How do animals respond to human interventions in the landscape and to changing climate conditions? What measures can be taken to protect and preserve endangered species? These are just some of the questions that scientists worldwide endeavor to get to the bottom of. Human existence depends on biodiversity. It forms the foundation for providing food, clean water, and numerous other ecosystem services that make life on the planet possible. In a time when global biodiversity is declining at an alarming rate, and actions to preserve it are becoming increasingly important, Movebank is a crucial project and tool for gaining knowledge and adjusting our actions accordingly.

Some of the data have been animated for the Frankfurter Kunstverein. They are presented as graphic lines moving on a 3D globe, revealing the routes of numerous animal species during their migrations. Animals travel far across the globe and bridge human-made borders. The lines show where and at what time different animal species are present, revealing a complex global network of habitats and ecosystems.

Biologist and ornithologist Prof. Dr. Martin Wikelski heads the Max Planck Institute for Behavioral Biology. He is also founder of the Icarus project (International Cooperation for Animal Research Using Space), from which the Movebank project emerged. Wikelski's team follows the concept of an "Internet of Animals". Thousands of tagged animals are tracked via satellite in their international movements and migrations, recording their positions, even in hard-to-reach areas such as oceans, deserts, or rainforests.

Movebank is a platform open to both scientists and citizen scientists. Anyone can participate and enter observation data into the database, becoming part of an international network. If tagged animals are missing or their location is indicated as stationary, a call can be issued to all community members to help search for animals in the field. The amount of data collected worldwide allows scientists to gain knowledge about animal migration and behavior, understanding complex relationships between human behavior and animals in order to advocate for conservation measures.

Movebank helps identify the impact of human interventions in the landscape and ecosystems and tracks changes in biodiversity. In Germany alone, an estimated one hundred million birds die prematurely due to reflective facades of high-rise buildings or air pollution. On the other hand, knowledge enables endangered species to be protected and recognizes that secure habitats offer them a home once again. Behind each animated light line of Movebank animation are countless individual stories stored in the database. Migratory populations of zebras in western Botswana, for example, have resumed long-distance journeys after years of short, chaotic routes because fences erected for economic purposes were removed. The zebras followed the original routes of their ancestors, even though they had no personal experience of them.

What the Movebank animation can convey is the extent to which human-made spaces, such as national borders, which animals cross, are relative. It also highlights the danger posed by thoughtless ecosystem destruction. The Movebank animation can create a sense of larger connections, much like astronauts experience when they see the Earth from space. They describe feeling a sense of wholeness when they see the planet without political boundaries, but in all its beauty from a distance, making them realize the profound fragility of life on Earth.

If you, dear visitors, are interested in participating in the Movebank project, please contact local environmental or conservation organizations or visit platforms like "Bürger schaffen Wissen" (www.buergerschaffenwissen.de). In Frankfurt am Main, for example, you can reach out to the following organizations: Senckenberg Gesellschaft für Naturforschung, Goethe-Universität Frankfurt, NABU, BUND, or SLInBio – Städtische Lebensstile und die Inwertsetzung von Biodiversität.

Or download the Movebank application on your mobile phone and actively participate in wildlife observation. The mobile Animal Tracker App can display the movements of tracked animals live on your phone. Ctmm: Continuous-Time Movement Modeling offers features for identifying, adjusting and applying random and continuous-time movement models for animal tracking data. Due to its user-friendly interface and accessibility via mobile devices, Movebank is also open to citizen scientists, allowing individuals to participate actively in scientific observations and data entry. Everyone can contribute to observations of animal populations, behaviors, and distribution areas of wildlife and keep records of sightings (online tools: Animal Tracker, Cat Tracker, or Snapshot Europe).

Lower floor

Fraunhofer Institute for Applied Polymer Research IAP

Prof. Dr. Alexander Böker, Director Fraunhofer-Institut für Angewandte Polymerforschung IAP
Dipl.-Ing. Thomas Büsse, Head of Verarbeitungstechnikum für Biopolymere Schwarzheide
Dr. Jens Balko, Head of Verarbeitungstechnikum für Biopolymere Schwarzheide
Heiko Ziller, Technical co-worker
Danny Pytek, Technical co-worker
Jens Kunkel, Design of experiments and compilation of exhibits
Fabian Textor, Scientific co-worker

Fresh-keeping containers, cream jars, cable pass-throughs, and screw caps (injection molding), yogurt cups and trays (thermoforming), drink and shampoo bottles (blow molding), films (flat and blown films) made from Polybutylene Succinate
Dimensions variable
Courtesy Fraunhofer-Institut für Angewandte Polymerforschung IAP

Plastics are used in all fields of application due to their material properties, from packaging in our everyday lives to high-performance components in aerospace. They have low material density and are cost-effective to manufacture. They require less energy input compared to other materials.

In 2021 alone, the production of plastics amounted to 391 million tons, and the trend is still increasing. About 90% of the produced quantity consists of commodity plastics such as polyethylene (PE), polypropylene (PP), polyethylene terephthalate (PET), or polystyrene (PS). These thermoplastic polymers represent a significant share of end products in the chemical industry and are almost exclusively made from fossil resources.

Only about 1.5% of plastics produced in 2021 are based on renewable resources. To successfully transform from an economy based on fossil resources to a sustainable circular economy, the share of renewable resources in global plastic production must increase significantly.

A problem as yet unresolved is the amount of plastic in the environment, in rivers, seas and soils. Plastic is intentionally discarded when waste collection systems are lacking, but unintentionally, too. Large quantities also enter the environment through abrasion and wear processes. Plastic particles can be found in all sizes, down to the micro- and nanometer range. The impact on flora and fauna, including the human body, is significant.

Bioplastics are currently produced to add to, and partly replace, commodity plastics. One example of a bioplastic is Polybutylene Succinate (PBS). PBS is particularly promising because it has similar mechanical, optical, and tactile properties to oil-based commodity plastics such as PE and PP. PBS is synthesized from two monomers: succinic acid and butanediol. These basic chemical building blocks are synthesized by a process known as polycondensation.

Both materials can be made from renewable resources derived from cellulose-containing waste from agriculture and forestry. Cellulose is broken down in a process, and the resulting sugars are fermented into succinic acid and butanediol using bacteria. In this way, 100% bio-based PBS can be produced from succinic acid and butanediol. This substance, along with polylactic acid (PLA), represents an important milestone in the transition to a bio-based plastics industry.

PBS is biodegradable and exhibits similar decomposition behavior to wood under suitable environmental conditions. Bacteria metabolize and break down PBS using their enzymes, leaving behind carbon dioxide and water as degradation products. If the use of biodegradable bioplastics were to increase in the future, the concerning spread of oil-based plastics in all biotopes of our planet could be reduced.

The production and use of plastic materials must be reduced and completely avoided as soon as possible. On the path to a fully sustainable economy, at least the rate of reuse and recycling of oil-based plastics, including bioplastics, must be top priority.

PBS, like most conventional thermoplastic plastics, can be recycled. It can be detected and sorted in modern sorting facilities. This means that a prerequisite for the recycling of all plastics is a modern facility with optical material recognition techniques in place and waste separation already carried out by consumers.

Recovered PBS can be incorporated into new products. Fraunhofer IAP collaborates with industrial partners to increase the variety of PBS types and so expand the range of applications. Using PBS does not require new processing technologies. The bio-based material can be used for injection molding, film production, blow molding and thermoforming. The sustainable materials developed at IAP are on the verge of being launched on the market.

Magna Glaskeramik

Stormy Grey Bodenplatten, 2017
24 Glass panels from recycled crushed glass and surplus coated solar panels
Each 135 x 60 x 2 cm

Samples
6 Glass tiles made from recycled broken glass and surplus coated solar panels

Courtesy Magna Glaskeramik

BlueBlocks: Seawood

Samples
Fibreboards made from brown seaweed
Courtesy BlueBlocks

RikMakes: Compostboard

Samples
Boards made from agricultural waste
Courtesy RikMakes

Plasticiet

Samples
Surface panels made from recycled plastic waste
Courtesy Plasticiet

Shards – Fliesen aus Bauschutt

Samples
Tiles from debris
Courtesy Shards – Fliesen aus Bauschutt

Smile Plastics

Samples
Panels made from recycled plastic waste
Courtesy Smile Plastics

Spared

Samples
Recycled shell from the fishing industry and recycled plastic waste

StoneCycling

Samples
Tiles and bricks from construction waste
Courtesy StoneCycling

UpBoards

Samples
Surface panels made from recycled plastic waste

Guts, 2019

HD-Video, 12:52 min
Mit der Insel Newfundland, CLEAR, Rick Chavolla, und Max Liboiron
Featuring the Island of Newfoundland, CLEAR, Rick Chavolla, and Max Liboiron
Kameraführung und Schnitt von Cinematography and Editing by Taylor Hess and Noah Hutton

The short film *Guts*, directed by Noah Hutton and Taylor Hess, addresses the responsibility of science and its independence in the service of socio-ecological transformation. The film's leading player is the research collective CLEAR in Newfoundland, Canada. Shot in the Beothuk and Mi'kmaq territories, which are inhabited by the indigenous communities of NunatuKavut, Nunatsiavut, and the Innu Nation, the film documents the collective's work. Led by Dr. Max Liboiron, CLEAR stands for Civic Laboratory for Environmental Action Research and describes itself as an activist, anti-colonial and feminist laboratory.

The collective represents a new generation of scientists who combine Western-shaped natural science methods with local indigenous traditional knowledge and ethical treatment of non-human beings and humans alike. CLEAR specializes in community-based, citizen-led monitoring of plastic pollution, particularly in wild food chains. Another area of focus is the development and application of anti-colonial research methods. The film illustrates the full extent of plastic pollution in the oceans and its impact on humans and nature, emphasizing the urgent need for sustainable materials and alternatives to plastic.

In the film, Dr. Max Liboiron explains that science is by no means apolitical. The history of science, technology and medicine is inseparable from the history of colonialism, imperialism and war. Even the decisions about which aspects of a phenomenon to investigate – such as the choice of quantification methods, the statistics used or created, the framing of issues, where results are published, who collaborates, who funds the research – all of this is political. It means that some structures and power dynamics persist and influence which knowledge is listened to and which is not. Dominant knowledge systems primarily reflect the perspectives of white, male, Western scientists, and this has led to a limited and biased understanding of the world. For this reason, the continuation of the status quo in scientific work is intrinsically political.

The work of the CLEAR Lab is informed by Donna Haraway and other feminist science scholars who coined the term 'situated knowledge' in the 1980s. According to Haraway and others, all knowledge is situated because it is produced by people in specific social, cultural and historical contexts. This perspective is especially important for feminist and marginalized viewpoints: Situated knowledge recognizes the diverse experiences and perspectives of different groups and values the knowledge that arises from these experiences. By acknowledging the situatedness of knowledge, we can become more aware of the power structures that shape the accumulation of knowledge and work towards creating more inclusive and equitable knowledge systems. CLEAR Lab is committed to applying new methods and ethics in science, as well as distributing knowledge and DIY research methods to citizens (known as Citizen Science).

Foyer 1st Floor

International Institute for Applied System Analysis, IIASA

David Leclère et al.
Bending the Curve of Biodiversity Loss, 2020
Infographic from: Leclere D, Obersteiner M, Barrett M, Butchart SHM, Chaudhary A, De Palma A, DeClerck FAJ, Di Marco M, et al. (2020). *Bending the curve of terrestrial biodiversity needs an integrated strategy*.
Courtesy Adam Islaam | IIASA

Katrin Böhning-Gaese, Friederike Bauer

Catalog of ten measures for biodiversity
Excerpt from: *Vom Verschwinden der Arten: Der Kampf um die Zukunft der Menschheit* (Böhning-Gaese und Bauer 2023)
Courtesy Katrin Böhning-Gaese, Friederike Bauer

Karlsruher Institut für Technologie, Fakultät für Architektur

Prof. Dr. Dirk Hebel
MycoTree, 2017
Mycelium and bamboo
100 x 100 x 150 cm
Courtesy Karlsruher Institut für Technologie, Fakultät für Architektur

The MycoTree is the result of a collaboration between the Chair of Sustainable Construction at the Karlsruhe Institute of Technology (KIT), the Block Research Group at the Swiss Federal Institute of Technology (ETH) Zurich, and the Department of Alternative Construction Materials at the Future Cities Laboratory in Singapore.

The Frankfurter Kunstverein is showcasing one of the prototypes of the exhibit, which was presented as a central work at the 2017 Seoul Biennale for Architecture and Urbanism. MycoTree illustrates how regenerative resources, combined with architectural planning, have the potential to create alternatives to established methods, and building materials for a more sustainable, bio-based construction industry. To achieve the requisite stability in construction, such sturdy traditional materials as metal and concrete are no longer relied upon, given their heavy ecological footprint and depletion of planetary resources. Instead, KIT focuses on stability through modified geometric design in the planning process. Led by Prof. Dipl. Arch. Dirk E. Hebel, a professor in the Department of Design and Sustainable Construction at the Faculty of Architecture at KIT, intensive research is being conducted on sustainable processes and materials for the construction industry.

The MycoTree is a model-like, spatial branching structure that was constructed from various mycelium and bamboo components. The name MycoTree refers to its tree-like structure. The form serves as a model of natural geometry, which is then further developed and calculated by architects and with the 3D-Graphic-Statics program. Within the MycoTree structure, modular components were attached using connectors made from bamboo, likewise a renewable resource.

The MycoTree is composed of organic materials. The white construction modules are made from residues of agricultural, forestry, or textile industries, held together by mycelium. The main production steps envisage particularly controlled conditions so that the living fungus finds optimal growth conditions. The organic residues are sterilized, fungal spores are added to them, and the mass is left to grow at 30 degrees Celsius for several weeks. If activation of the fungus is successful, it can grow at a rate of one to five centimeters per day and colonize the substrate. Once the mycelium has fully penetrated the substrate, growth is halted through drying and subsequent compression. The root filaments of the fungus compact the originally loose substrate into a solid form, replacing thereby the need for toxic adhesives. This also makes the material completely biodegradable. The shape of the containers in which the fungus grows determines the final shape of the module, as well as the success of the living fungus growth process.

These mycelium modules are connected to bamboo parts using connectors to increase the stability of the object. Bamboo is also a rapidly growing plant that can grow up to one meter in height per day. It is flexible and robust, and has played a central role in Asian construction for centuries, including in modern high-rise construction. Unlike trees, bamboo requires less water, no fertilizers, and grows much faster.

However, mycelium material is neither particularly flexible nor tensile. For this reason, a form of innovative architectural and structural planning needs to be developed with the characteristics of organic materials. The MycoTree was created as a prototype and module at KIT Karlsruhe to test its load-bearing capacity.

International research has been conducted on the method of mycelium preparation from organic waste for years, and patents filed. Today, numerous methods and suppliers of different materials exist, whose texture range from light but crumbly to hard and compact. These meet various construction project and interior design needs, such as sound absorption, low flammability, sealing properties, or the ability to be pigmented. In biochemical terms, during their growth both the fungus and the bamboo plant bind nitrogen and carbon, which are stored in cellulose.

The 21st century is on the brink of a radical paradigm shift in how we produce materials for building our living spaces. The linear concept of "produce, use, and dispose" has proven unsustainable for living on the planet in future, given the scarcity of resources and exponential growth of urban populations. To achieve a circular cycle of production, entailing use and reuse, alternative materials and construction methods must be explored and then implemented.

A shift in mindset has occurred in the international architecture context, as shown by the 2023 Venice Biennale for Architecture. However, neither construction practices and the supply industry, nor regulatory and political frameworks reflect the transition to a new way of building. Rapid urbanization, global resource consumption, and the associated ecosystem destruction remain some of the greatest challenges of the 21st century.

Prof. Dipl. Arch. Dirk E. Hebel founded the research institute he leads in the belief that a paradigm shift must urgently make headway in the construction sector. Since 1990 alone, estimated greenhouse gas emissions from the cement industry worldwide have tripled. The global construction industry requires exponentially increasing amounts of wood, water, soil resources and energy. This makes it a major contributor to deforestation, land consumption, water pollution, and non-recyclable construction waste. The extraction of sand that is used in concrete production depletes ecosystems. Sand is taken from rivers, coastlines, and sea beds, leading to habitat destruction for humans, animals and plants.

With a growing population and rising demands, the need for materials and resources to satisfy them is also increasing. While in the past, this demand on resources was met locally and regionally, it is now becoming increasingly global and far-reaching. This phenomenon has led to the emergence of material flows of transcontinental and planetary significance. These have profound implications for the sustainability, functioning, ownership and identity of future cities. The global concentration of the construction industry on a few select materials is putting significant pressure on our natural resources, however. In any discussion of cities of the future, it becomes that clear that they cannot be constructed with the same resources as those employed in existing cities.

Like many other participants in *Bending the Curve*, Dirk Hebel is an active advocate for circular economic models. This approach views materials as precious, finite resources and actively promotes their reuse and conservation. Efficiently using resources, minimizing waste, extending the lifecycle of products, and promoting material recycling: these are all possible strategies. The time for linear models, where products are discarded after use, must be left behind. A circular economy, a culture based on repair, or at the very least recycling, would have to be promoted politically to ensure that our planet remains inhabitable into the future.

1st Floor

Fernando Laposse

Pink Hammock, 2019
Hammock, woven sisal, dyed pink
200 x 400 x 100 cm

Three dog benches (pups), 2023
Weaven agave fibers, plywood structure
Each 67 x 40 x 45 cm

Totomoxtle, 2023
Polygonal multi-colored corn panels
12 m^2

Agave Regeneration, 2019
Video
5:34 min

Totomoxtle – Biomaterial Made from Mexican Heirloom Corn Husks, 2019
Video
7:19 min

Courtesy Fernando Laposse

Fernando Laposse views art as a socio-ecological action. For *Bending the Curve*, the Mexican artist has conceptualized a room installation spanning over 140 square meters, in which the products of the indigenous Mixteco community are presented as exhibits in a staged landscape. Laposse founded a cooperative with them in the rural area of Tonahuixtla, where he combines local knowledge, ecological restoration, social community life, and sustainable economic practices. The artist revitalizes fallow areas, prevents soil erosion, and advocates for food sovereignty and the protection of cultural plant diversity and indigenous knowledge.

In this exhibition, Fernando Laposse focuses on two natural materials from Tonahuixtla: corn leaves and sisal fiber. These natural products are collectively produced, processed in the traditional manner in the cooperative, and transformed into contemporary artworks when placed in a museum context. The colorful *Totomoxtle* intarsia panels made from corn leaves are displayed on the wall. The *Pink Hammock* and the three sculptural *dog benches (pups)* are crafted from sisal fiber derived from agave plants. The two films, *Agave Regeneration* and *Totomoxtle – Biomaterial Made from Mexican Heirloom Corn Husks*, reveal the history of the artworks and the Tonaxuitla community.

Laposse began collaborating with the indigenous Mixteco community in Tonahuixtla in 2015. The rural village is located less than 50 kilometers from the world's oldest archaeological site of maize domestication—a plant that has always played a central cultural and financial role in the community's identity. The history of this place is marked by socio-ecological challenges that began in the 1990s with the introduction of hybrid maize seeds and the abandonment of traditional farming methods. This development led to a range of problems, including soil erosion, migration, unemployment, and the loss of agrobiodiversity and endemic plant species, especially maize.

Tonahuixtla is not alone in its history; it exemplifies the fate of countless rural communities in South Asia and Latin America affected by the spread of new agricultural systems. In Mexico, agricultural modernization began in the 1950s with a focus on increasing domestic demand. This led to the intensified use of high-yield but less resilient and adaptable industrial seeds that rely on expensive synthetic fertilizers, pesticides and machinery. In just a few years, Mexico lost 80% of its maize diversity. The consequences of these changes were particularly severe in Tonahuixtla, where the soils were severely depleted, and many residents became dependent on large corporations, leading them to emigrate to the United States to make a living.

Laposse, who had been visiting the Tonahuixtla community since childhood, returned there after studying art in London to find a village on the brink of extinction. To signal change and hope for the community, he initiated *Totomoxtle*: a socio-ecological artistic project aimed at reintroducing native maize varieties in collaboration with local families who had preserved traditional seed varieties for generations and the International Maize and Wheat Improvement Center (CIMMYT) seed bank in Texcoco, Mexico. In just four years, more than 50 people were employed, and six endangered maize varieties were reintroduced into local agriculture. Working together with the cooperative he founded, Laposse used the colorful leaves of criollo maize, usually agricultural waste, to create intarsia for furniture and interiors. The name of this new material, *Totomoxtle*, refers to the indigenous Nahuatl word for corn husks. It is veneer, 0.5 to 8 mm thick sheets, typically made from wood and, in this case, from maize farming remnants. After being cut from the plant, corn leaves retain their color and can be flattened or bent due to their fiber structure. The production of *Totomoxtle* created jobs locally and motivated the community to return to traditional farming practices. Craftsmanship became a driving force for socio-ecological transformation on a small scale.

In a second step, Laposse and the cooperative sought a solution to the severe problem of soil erosion, leading to the reintroduction of agave plants on a 120-hectare area. Up to 150,000 agaves were planted. Their roots can anchor to rocks, preventing soil erosion, storing water in dry soil, and strengthening ecosystem resilience. However, the use of agave plants in Tonahuixtla differs from their typical use in Mexico. Agaves are usually grown industrially to produce the national spirits Mezcal and Tequila. For this, the agave plants are cleared from the fields, and their leaves are left as waste, leading to insect infestations and potential soil harm from excess leaves. In Tonahuixtla, the agave plants are preserved. Only their leaves are harvested and ground to obtain sisal fibers, which are woven into textile sculptures. The three dog benches (pups) sculptures at the Frankfurter Kunstverein showcase the natural "blonde" color of sisal. In contrast, the *Pink Hammock* sculpture was dyed with a natural pigment. The red pigment cochineal is produced by a beetle that grows on cacti in Central America.

In Laposse's reforestation project with agaves, the production of textiles from sisal becomes an act of care that distances itself from the conventional textile industry, which depletes natural resources faster than they can regenerate. Laposse's communal practice goes beyond sustainability, regenerating ecosystems and communities to preserve local biocultural wealth for future generations. He demonstrates the regenerative power of art to address complex issues and shows how art can provoke not only aesthetic but also socio-ecological transformation. Laposse acts in favor of a financially independent community that operates in harmony with the local ecosystem. Landscape and people join up in Tonahuixtla in an ecologically oriented economic cycle, underscoring the importance of awareness and promoting change, not matter at what level it occurs.

The presentation of Fernando Laposse's work in the exhibition *Bending the Curve* exemplifies a whole range of artists who use their art to advocate for the preservation of agrobiodiversity and a shift in agricultural practices through local solutions and research approaches. This includes artists like Vivien Sansour with the *Palestine Heirloom Seed Library*, Marwa Arsanios with her film trilogy *Who is Afraid of Ideology?*, Jumana Manna with her films *Foragers* and *Wild Relatives*, Nida Sinnokrot with the residency program *Sakiya – Art/Science/Agriculture*, as well as the artist duo Cooking Sections with their art research projects *CLIMAVORE* and *Monoculture Meltdown*.

BACKGROUND ON THE FOOD SYSTEM

The climate crisis confronts our food system—agriculture, forestry, fisheries, and aquaculture—with new challenges, such as rising temperatures, wildfires, droughts and floods. What we eat, how much food costs, where land can be cultivated, and how much food people have access to are closely tied to biodiversity and increasingly unpredictable climate conditions. Throughout its evolution, nature has continuously adapted to different climate zones by relying on genetic diversity. This provides humans with a broader range of plant species to cultivate.

The diversity of organisms living in our agricultural ecosystems is referred to as agrobiodiversity. This includes crop plants, livestock, microorganisms and wild plant species. It is largely a cultural heritage created by humans over centuries, making it a unique form of biodiversity. Agrobiodiversity encompasses not only agriculture and food but also history, tradition, identity, culture, geography, genetics, science and craftsmanship. As the genetic foundation for food and agricultural production, our future depends on it. Agricultural diversity enhances the overall resilience of our food systems, allowing for the breeding of more resistant plant varieties that can better withstand challenges like diseases, pests, changing environmental conditions and other threats. Due to global warming, increasingly harmful pathogens that destroy crops and wipe out entire plant species are spreading. However, today, agrobiodiversity is under significant threat, and so is the future of human nutrition.

Like the climate crisis, the diversity crisis is human-made. The most significant loss of plant diversity began in the 1960s when scientists attempted to preserve global food security by increasing the yields of wheat, rice and maize. To cultivate the additional food needed urgently, thousands of traditional varieties were replaced by a small number of new hybrids (especially in maize and soybeans). These hybrids were initially selectively bred and later genetically engineered. The strategy that guaranteed this using new technologies—more agrochemicals, increased irrigation, new genetics and improved seed varieties—became known as the "Green Revolution". This movement was supported by various organizations and scientists, including the

Rockefeller Foundation and the Ford Foundation, as well as agricultural scientists like Norman Borlaug. The Green Revolution spread worldwide, particularly in South Asia and Latin America, marking the beginning of modern industrial agriculture, also in the interest of large corporations. The introduction of hybrid varieties sometimes intensified the use of agrochemicals—fertilizers, pesticides, and herbicides. Only four agrochemical companies control 60% of the global seed market (and 75% of the pesticide market) and have an interest in making agriculture dependent on them. Due to their reliance on external inputs and the dominance of a few corporations, local small-scale farming communities faced difficulties, and their resilience and traditional agricultural knowledge were lost. While the new practices and scientific knowledge were able to alleviate acute hunger issues in some regions, in the long run they sidelined biological diversity, local food systems, social justice, and the health of soils, ecosystems and water bodies.

In response to the negative effects of globalization and industrialized agriculture, protest movements by farmers, agricultural laborers, and indigenous communities emerged in the 1990s, opposing industrialized global agriculture and prioritizing local solutions. They propagated the concept of food sovereignty, which challenges the dominant model of food security as a priority. Food sovereignty refers to the right of individuals and communities to have control over their own food systems, including how food is produced, distributed and consumed. The focus is on local and traditional knowledge and sustainable agricultural practices (agroecology).

Today, several plant species familiar to us from our daily lives are affected by the loss of agrobiodiversity. A well-known example is the story of bananas. Of the over 100 species of Musa Paradisiaca (banana) that evolved through natural selection, the seedless Gros Michel was cloned and spread worldwide. After Gros Michel plantations were nearly wiped out by a soil fungus, the industry turned to a fungus-resistant variety: the Cavendish banana. However, as a single variety, it is susceptible to new fungi and pathogens at any time. More and more plants that have been reduced to a few varieties are exposed to the dangers caused by climate change: popular examples include Hass avocados, Arabica coffee, cocoa, as well as apples and potatoes, and many more. But above all, plants on which global nutrition depends are at risk of losing their diversity: wheat, rice, and maize. Virtually all industrially grown foods have experienced similar mistakes—optimizing yields and profits in the short term but sacrificing the diversity and survival of food crops in the long term.

However, all hope is not lost. As the Green Revolution accelerated the decline of genetic species diversity, it triggered globally organized efforts to find and preserve diversity in gene or seed banks. Seed banks are a resource to prevent a global food crisis due to the increasing endangerment of plant species worldwide. Researchers working at seed banks search for populations and old varieties to breed climate-resistant or more adaptable varieties that can withstand more uncertainties. There are now approximately 1,700 seed banks worldwide that house collections of plant species, invaluable for scientific research, education, conservation, and the preservation of indigenous cultures.

The concept of gene banks has proven moderately successful in rescuing staple foods, but it has been much less successful for vegetables and fruits. And while storing seeds under carefully controlled conditions is no easy task, many foods like coffee, apples, peaches and vanilla must be preserved as plants or trees, posing an even more complex and expensive challenge. One solution could be to bring diversity from seed banks back to the fields of farmers, where old varieties can become part of the genetic heritage once again.

The environmental activist and 1993 Alternative Nobel Prize laureate Vandana Shiva has studied the damaging effects of monoculture agriculture. Her works shows that, as a result of the Green Revolution, not only have ecological and environmental problems developed, but also a monoculture mentality among farmers and decision-makers (Shiva 1993, Monocultures of the Mind – Perspectives on Biodiversity and Biotechnology). Shiva argues that monocultural thinking has led to a narrow, reductionist view of complex issues, suppressing in turn diversity of thought and solutions in favor of uniform solutions. Complex socio-political and ecological contexts have been ignored, natural systems simplified.

In contrast to technological solutions (known as techno-fixes) based on genetic engineering, agroecologists and regenerative farmers argue that the most efficient and sustainable food systems are those that use techniques that mimic nature rather than dominate it with artificial means. Applying traditional knowledge does not mean going back to the past; it means looking at the various food systems that people have preserved for millennia in harmony with nature and considering how these practices can best be applied within local approaches in the modern 21st-century food system.

2nd Floor

Julia Lohmann

Hidaka Ohmu, 2020
Algae glued to rattan and laminated wood
535 x 325 x 224 cm

Corpus Maris II, 2023
Algae glued to rattan and laminated wood
150 x 150 x 130 cm

Department of Seaweed
Studio space: Various prototypes, work samples and material
Algae veneer, rattan constructions, sketches, dried algae from various countries in Europe and Asia as well as Australia, pictorial material, reprint of the PhD Appendix, algae hanging on ropes, cutting mat, workshop utensils, drawings and collages

Courtesy Julia Lohmann Studio

Julia Lohmann is an artist and professor of contemporary design practices at Aalto University in Helsinki. For years, she has been researching the characteristics and living conditions of seaweed and kelp. Lohmann follows the idea of “Knowing, Acting, and Caring,” which she has worked out structurally in graphic models of the linked relationships between humans and nature. The artist represents an approach in which Cartesian dualism is overcome, and the element that binds humans and non-human beings is acknowledged. The focus here is on understanding the complex, mutual relationships of beings, all of which are part of an interdependent overall system.

Since 2007, Julia Lohmann has been using seaweed as the material for her large-scale sculptures and artistic work. Seaweed is a rapidly growing macroalgae that forms dense underwater forests or fields. They obtain all the necessary nutrients for their growth from seawater, the atmosphere and the sun. They absorb large amounts of carbon dioxide, produce oxygen, cleanse the oceans, and provide habitat and food for other organisms living there. They contribute to the prevention of coastal erosion by weakening the force of waves and serving as a natural barrier.

With every breath humans take on the planet, half of the oxygen comes from algae and plankton inhabiting the world's oceans. For billions of years these photosynthetic organisms have been responsible for the unique composition of our planet's atmosphere and so for all life upon it. In the oceans, they are at the beginning of the food chain, upon which countless other creatures, including humans, directly depend.

For *Bending the Curve*, Julia Lohmann has conceived a large room installation with several elements. *Corpus Maris II* (Latin for "sea body" or " sea creature") is a sculpture hanging from the ceiling, the shape of which resembles a jellyfish body. *Hidaka Ohmu* stands in the center of the room. This sculpture is a walk-through, organically shaped pavilion, whose shell is made of semi-transparent seaweed stretched over a lightweight rattan frame. The giant sculpture is installed on walls, virtually seeming to grow out of them. Passing through it brings the visitor to another room, reminiscent of a studiolo. This space is dedicated to the investigation of art, societal and aesthetic insights, and the properties of algae, and has been called the Department of Seaweed by Lohmann.

These works exemplify the process-oriented and experimental way in which Lohmann works with seaweed, using art to shed light on overarching questions about human actions in and in relation to ecosystems.

The title *Hidaka Ohmu* establishes a connection to Japan, where the artist began her research on marine plants years ago. In Japan, kelp has been harvested for generations and is an integral part of the culture and nutrition there. "Hidaka" is a region on the Japanese island of Hokkaido, whence the kelp originates. "Ohmu" is the name of insect-like fantasy creatures from the Japanese animated film "Nausicaä of the Valley of the Wind" (1984) by author Hayao Miyazaki. In his story, the Ohmu protect the forest and restore the ecosystems of soil and water that humans have disrupted.

The central idea of "Wabi Sabi" in Japanese culture is of great significance to Lohmann's work. Impermanence, imperfection and transience are seen not as limitations but as potentials for future existence. In terms of form, Lohmann repeatedly incorporates the unfinished, the non finito, into her works, which in the Wabi Sabi idea emphasizes openness to all that is becoming, to the ambiguous, to the realm of speculation.

In the context of art, craft, and design, this means appreciating the qualities of materials in their natural imperfection and leaving them in a way that they remain undistorted. Their thoughtful design should activate the viewer's imagination, creating space for ambiguity.

The works change over time. Humidity, temperature, and light transform the texture and color of the algae stems and as a result, Lohmann's sculptures. The plant stalks dry out and contract as part of their natural process. The artist treats the kelp with linseed oil to keep it flexible enough to stretch over the rattan structure. While fragile materials have short molecular chains, soft materials have long ones. In wet seaweed, the molecular chains are linked by the water. During the drying process of the algae, the water evaporates, the molecular chains shorten, and the fibers contract. To stretch the algae in a way similar to leather, Lohmann has developed a method to retain sufficient water in the hydrophilic material. Seaweed and rattan provide mutual support: seaweed provides traction, and rattan stability.

The color of the seaweed also undergoes continuous change in Lohmann's works. The seaweed leaves of *Hidaka Ohmu* and *Corpus Maris II*, originally green due to chlorophyll, are now seen in the exhibition in a warm, translucent yellow.

In the proportions of her sculptures, Lohmann follows the size of harvested algae stems. Seaweed, especially Saccharina Japonica, can reach lengths of up to six meters and widths of forty centimeters in just one year. Lohmann tries to use the marine plants as a whole length of material to maintain the appearance and impression of their natural form underwater.

Lohmann endeavors to alienate the biological material as little as possible. She views seaweed not as a raw material but as a living, process-based, autonomous organism with which she interacts. The artist would like to preserve its properties and render its "Seaweedness" visible. She attributes agency to the living being that is seaweed; it is not lifeless, not passive, and so not just a provider of material but a living being with which humans engage in a relationship through their actions.

As a result, the sculptural installations are not just surfaces perceivable through external observation. *Hidaka Ohmu* can be walked through. Visitors enter its interior through passages into the sculpture's belly. Mirror surfaces in the passageway create duplications and illusions. Inside, there is the scent of the sea and the many different algae that Lohmann displays, translating her workspace into the exhibition space. Various prototypes, work samples, and seaweed in its raw form and various drying stages are on display. Ongoing rattan constructions, sketches, mind maps, and a printout of Lohmann's doctoral thesis provide insight into her research and production practices. It is not the finished, museum-like work, but the process, the work, the researching, and the tactile aspect that captivate Lohmann.

Lohmann works within a "community of practice," collaborating with people from various disciplines. She practices the method of co-speculation: anyone can provide imagination and associative power and so contribute to possible future forms of caring for and acting with seaweed. Lohmann has conducted numerous *Department of Seaweed* (DoS) prototyping workshops at universities, cultural institutions, and even for political bodies like the European

Parliament. In 2020, Lohmann was invited by the World Economic Forum in Davos to showcase *Hidaka Ohmu*.

To ensure that the knowledge generated and research results on seaweed continue to expand, yet remain accessible to the public, Julia Lohmann was guided by the Creative Commons (CC) licensing system: all contributions and research results created as part of the Department of Seaweed are subject to CC license conditions. The dissemination and use of research results are encouraged provided they align with the principles of sustainability.

Lohmann is part of an approach that demands reciprocity as a principle of interaction with others. Emerging from indigenous knowledge and actions, now increasingly woven into Western thinking, reciprocity is the practice of exchanging things with others for mutual benefit. Reciprocity is not limited to fellow humans but requires a mindful approach to all fellow living beings. Lohmann's Department of Seaweed represents a regenerative design research practice that embodies an ethical stance.

450 million years ago, evolutionary processes led to the first plants evolving on land from marine algae. Marine plankton, the primordial organism capable of photosynthesis, released oxygen into the atmosphere billions of years ago. This laid the foundation for the development of more complex life forms on Earth. Algae are the origin of the plant world on Earth. Various disciplines in bioeconomics increasingly research algae and seaweed today. These plants grow rapidly and have the ability to filter heavy metals and pollutants from water. They can be cultivated and harvested in an environmentally friendly way. Known as the "sea bamboo," seaweed can also filter harmful excess nutrients from agricultural runoff (nitrate) and fish excrement, stop coastal erosion, and promote coastal area regeneration. Grown near fish farms and industrial facilities, seaweed can filter water and at the same time be harvested as a renewable material. Thanks to its texture, seaweed is increasingly used as an eco-friendly alternative to plastics, textiles, or leather-like materials that require no harmful processing.

A holistic approach that considers the entirety of ecosystems and all beings participating in them may potentially lead to more sustainable economies and communities in the future. The approaches to dealing with seaweed are promising, but sustainability largely depends on careful use during harvesting, processing and utilization. Growing awareness suggests that a fundamental change in human attitudes toward our fellow beings and resources is needed. The survival of humans is intertwined with that of seaweed and all other inhabitants of the oceans. For Julia Lohmann, working with seaweed symbolizes a non-exploitative approach to nature. Her works thus create spaces for thought that can inspire concrete actions and attitudes in various disciplines.

Alexandra Daisy Ginsberg

Pollinator Pathmaker: AfyLbwTriWhuR7PDkd77LZ (Pollinator Vision, Late Spring)
Pollinator Pathmaker: ARr77zvQW8Bq8q6hgDHUmp (Pollinator Vision, Late Summer)
Pollinator Pathmaker: AfyLbwTriWhuR7PDkd77LZ (Pollinator Vision, Late Summer)

Pollinator Pathmaker: iFADDiPqc5HU3KiFxjBEuG (Pollinator Vision, Early Summer)
Pollinator Pathmaker: AfyLbwTriWhuR7PDkd77LZ (Pollinator Vision, Midsummer), 2023
Five pigment prints on Baryta paper with landscape creations made with the software *Pollinator Pathmaker*
Each 203 x 125 cm
Commissioned by Frankfurter Kunstverein

Pollinator Pathmaker, 2021
Online Tool pollinator.art
© Alexandra Daisy Ginsberg Ltd

Courtesy the artist

Alexandra Daisy Ginsberg, who works at the intersection of art, ecology, and technology, has created a new series of works for the Frankfurt Kunstverein. Five large-scale prints depict the different seasons of as yet unrealized *Pollinator Pathmaker* living artworks. The chosen perspective of her pictures is that of pollinating insects. *Pollinator Pathmaker* is Ginsberg's ongoing artwork in which the artist transforms plots of earth into biodiverse landscapes. She developed an algorithm that creates site-specific planting schemes, that once planted, become living artworks for other species. The algorithm designs planting not on human aesthetic criteria, but on the needs and foraging styles of pollinating insects, including bees, wasps, moths, beetles and butterflies. The selection of plants is based on the specific bioregions where *Pollinator Pathmaker* "Plant Palettes" have been commissioned so far – currently Atlantic Europe and Continental Europe. These plant lists are researched and curated by the artist, working with horticulturists and pollinator experts.

Each garden is a unique creation with a one-off planting plan that supports the maximum diversity of local pollinator species. The artist refers to the technology she created as an "altruistic algorithm" or an "empathy tool", since its prioritization was designed to maximize benefits for pollinators, not humans. Factors such as pollinator types, flowering times, plant compatibility, flower shape, and their visual perception spectra of color frequencies are considered. The algorithm calculates the selection and arrangement of plants with flowering across the year and different foraging styles are catered for: Some insect species memorise the most efficient routes between flowers to collect as much nectar as possible with minimal energy expenditure, while others explore more randomly.

For *Bending the Curve*, five large-scale prints have been generated of unrealised planting schemes, none of which depict the human perspective. Alexandra Daisy Ginsberg digitally paints each plant that appears in her Plant Palettes, making it possible to visualise each potential living artwork in a virtual space before it is planted. Ginsberg has flown through the digital gardens and chosen the viewpoint of pollinators, i.e., from a low flight or ground angle. The colors of the flowers infer the different colour perception spectra of different insect species. Ginsberg deliberately breaks with the principles of classical landscape painting. One could almost think of it as an extreme expansion of the concept of English landscape gardens. In the 18th century, these gardens broke with the mathematically geometric arrangements that characterized the then-dominant French Baroque gardens to approximate the natural arrangement of plants.

Despite the use of technology, Ginsberg explicitly distances herself from the idea of solving climate and biodiversity crises through so-called techno-fixes. Rather, she advocates for fundamental changes in human behavior, political decisions, and economic actions. Alexandra Daisy Ginsberg's work is guided less by an idea of reparation than by one of caring for our non-human co-inhabitants. *Pollinator Pathmaker* aims for a change in perspective both in the observation and design of our interaction. To detach from a purely human, anthropocentric view means to perceive and acknowledge the diverse worlds of non-human creatures.

Alexandra Daisy Ginsberg represents an understanding of art that focuses not only on the artwork itself but on an attitude. She creates long-term projects based on scientific foundations, intervening in real societal space through an expanded concept of art. *Pollinator Pathmaker* activates people and engages them in community planting actions. Living works emerge on the surfaces as social sculptures in public spaces that transcend individual species. For this, she actively seeks collaboration with cultural institutions. For example, on behalf of the LAS Art Foundation, a *Pollinator Pathmaker* artwork has been planted in the forecourt of the Museum für Naturkunde Berlin, another in Kensington Gardens for the Serpentine Gallery in London, and a third one at the Eden Project in Cornwall, UK. Ginsberg views each commission as an art edition of a continuously growing series of living, process-based artworks.

Wishing to share her knowledge, the artist makes the *Pollinator Pathmaker* algorithm available to the public on the pollinator.art website. Visitors to the site can create their own planting plan, ranging in size from a flower box to an area of 15 x 15 meters. The algorithm calculates individual designs for planting based on the size and geographical location of the area, soil type, light, and exposure. The system generates a unique design, provides a planting guide and basic information on recommended plants, their development in different seasons; it also visualizes the garden both from a human perspective and that of pollinators using Ginsberg's digital paintings. Ginsberg's vision is to generate as many collaborators as possible to use *Pollinator Pathmaker* to create site-specific artworks for insects across the globe. The ultimate goal is a globally distributed artwork with collective authorship that is used by non-human creatures. Each edition would serve as another stepping stone for pollinators, contributing to the creation of a cross-border artwork and network.

Regeneration, as advocated by environmentalist Paul Hawken in his book "Regeneration: Ending the Climate Crisis in One Generation", means placing life at the center of every action and decision made by society. At the heart of this lie ethical questions concerning species and the need for practical solutions. Examples would be how humans and other beings can fairly share spaces, and how best to radically reset and reorient our relationships with, for example, insects. It would mean acknowledging that all growth is based on reciprocity.

In contemporary art, artists have been contributing ideas and practical instructions for regenerative approaches for years. Regenerative action calls for a rethinking of how we shape and create the environment already built. Such actions contribute fresh ideas to improving the resilience of society, restoring the health of the planet, and renewing ecological systems. In this context, Alexandra Daisy Ginsberg's work, *Pollinator Pathmaker*, represents a pioneering outlook—a stance of empowerment in the fight to preserve biodiversity.

POLLINATORS AND FLOWERS: A (NOW ENDANGERED) SYMBIOSIS OF OVER 200 MILLION YEARS

Bees, butterflies, moths, flies, beetles, and wasps are among the pollinating insects, of which there are 350,000 species worldwide. They land on flowers to drink nectar or feed on pollen, transporting pollen grains from place to place. This helps plants in their reproduction and distribution. Since plants cannot move, they "cooperate" with insects to ensure their own existence. The sheer beauty of flowers, including their vibrant colors, is crucial in attracting pollinators. Insects are particularly drawn to blue colors, which are rare in nature. Some flowers create optical effects such as iridescence to attract them. Scent also plays a central role.
New research at Tel Aviv University (Prof. Lilach Hadany, Molecular Biology Ecology of Plants, Faculty of Life Sciences) focuses on phytoacoustics, the study of the effect of sounds on plants. These researchers' findings show that flowers perceive vibrations from approaching insects and respond by producing sweeter nectar for them. This type of symbiotic relationship is called "mutualism". Indeed, the reciprocity between plants and pollinating insects has accelerated the evolution of flowering plants. They are able to adapt to the physical characteristics of insects within a few generations.

Wildflower meadows are among the ecosystems with the highest biodiversity. One-third of native plant species, pollinating insects, and other animal species live in wildflower meadows. In the last century, approximately 98% of wildflower meadows disappeared due to land sealing, conversion of land into monocultures for agro-industrial agriculture, intensive use of manure and synthetic fertilizer, and short mowing intervals. With state financial support and substantial funding from tax revenue and EU subsidies, nutrient-poor meadows are being transformed into profitable grasslands. The threat to wildflower meadows as habitats is directly linked to the decline of pollinating insects.

A decline in pollinator insect biodiversity is also directly linked to a decline in plant diversity. The rapid decline of species impoverishes ecosystems and, ultimately, it threatens human survival. After all, pollinators support ecosystems and three-quarters of the world's food system. A new mindfulness for the needs of insects would mean securing our life on the planet – not only because these creatures benefit humans (nature for people, IPBES), but also because they have value by their very existence (nature for nature, IPBES). The value of a living being cannot only be measured in monetary terms.

Taking into account that land use change is a direct trigger for species extinction, the destruction of ecosystems and thus the disappearance of insects, the return of space to nature is a regenerative solution approach called for by numerous international scientists (Bending the Curve of Biodiversity Loss; IPBES; Club of Rome).
3rd Floor

Zoo Frankfurt

Exhibit developed by Dr. Johannes Köhler
Colony of atta leaf cutter ants
System of tubes and cubes with ants, food chambers, waste chambers
Various sizes
Courtesy Dr. Johannes Köhler, Zoo Frankfurt

Thanks to a collaboration with Frankfurt Zoo, the Frankfurter Kunstverein presents a colony of leafcutter ants that will inhabit the exhibition rooms for the duration of the exhibition. Guided by curator Dr. Johannes Köhler, Frankfurt Zoo has raised the ant colony up in glass enclosures. This allows visitors to observe up close the complex lives of these animals, which typically occur underground. Leafcutter ants are native to the tropical rainforests of Central and South America. They live in a complex yet highly efficient symbiosis with fungi. This reciprocal mode of existence enables both species to support or even make possible each other's life functions. The symbiosis is so close that the two cannot exist without each other. Leafcutter ants are one of several ant genera that have developed this way of living.

Ants are an essential part of functioning ecosystems. They cultivate other insects (coexistence), feed on them (pest control) among other sources, spread plant seeds, dispose of dead organisms, and aerate soils with their complex burrows. They transport large amounts of nutrients to deeper soil layers, making them more fertile. Ants process substantial amounts of green plants, helping to maintain the nutrient cycle and promoting vegetation growth.

Symbiosis
Working collectively, the large leafcutter worker ants use their mandibles to cut plants into smaller pieces and bring them into their nests. In specialized chambers, the ants cultivate so-called "fungus gardens". The small worker ants in these chambers then chew the leaves into a pulpy mass, which serves as a substrate for the fungi. They carefully groom the surface of the fungal network, cleaning it of spores and fungal threads from other mold species. They repeatedly pluck small pieces from the fungal structure to feed to their nestmates. They also place new fungal threads on fresh plant material to cultivate more cultures. The ants also fertilize the fungus with waste products and their feces. The plant components, hard to digest, are collected by the ants and rooted, then decomposed by the fungal mycelium, converting them into a digestible substrate for the ants. Studies suggest that the ants carry bacteria on their bodies that not only inhibit the growth of harmful fungi but simultaneously fertilize the nutrient fungus as well.

In return, the fungus forms protein-rich nodules at its ends, providing the ants with proteins to feed their larvae. Additionally, the fungi break down the cellulose in plants, making it digestible for the ants. The fungus is able to break down toxins harmful to ants. The growth of the fungus depends directly on the food supply and the number of workers caring for it. The size of the ant community, in turn, is proportional to the size of the mycelium. The queen, through the number of larvae she lays, ensures that the population in the nest corresponds to the available food supply.

Architecture of Ant Nests
Leafcutter ants build underground nests consisting of a complex network of tunnels and chambers. Nests can encompass up to 70 square meters underground and house several million ants. The various chambers serve specialized functions crucial to the population's survival.

The fungus chambers are the central rooms of the nests. In waste chambers, ants dispose of plant remnants from the fungus chambers. The ant queen lays her eggs in the brood chambers, where the larvae and pupae are also nurtured. The brood is cared for by the worker ants. In addition to the fungi, the ants also store food reserves in special storage chambers. The reserves consist of fungi but also leaves, flowers, seeds, and animal remains. Each colony builds its nest individually. Changes in their environment and external conditions are responded to by adapting their nest architecture. The correlations at play here are not yet fully understood. The diversity of ant nests is demonstrated by the work of Walter R. Tschinkel.

The Diversity of Ant Populations – Swarm Intelligence
Leafcutter ants, like all ant species, function as swarm intelligence. Each individual carries a limited amount of information. Coordinated interaction and communication give rise to efficient solutions for complex tasks through collective intelligence without a central authority. The ant population operates through a complex, emergent system of individuals possessing only local information. Ants have no knowledge of the overall state of the community but function through mechanisms based on social coordination. Ant trails, for example, form when individual ants leave a pheromone trail while searching for food. If an ant uses this path repeatedly, the trail becomes stronger.

Social Structure
Queens are the reproductive females in the population. They are significantly larger than other nestmates and are solely responsible for laying eggs. An ant colony typically has only one queen, with multiple queens being the exception. Queens are the only female ants capable of laying eggs. Also, queens and males are the only members of the population that can fly. This ability is important during the mating season and for founding new colonies.

The primary function of male ants is to fertilize the queens during the mating flight. Males are smaller than worker ants and usually have a short lifespan. After fulfilling their reproductive role, they die.

Worker ants are non-reproductive females. Workers can be divided into various castes and can vary in size within a population. Comprising the majority of the colony, they are responsible for gathering leaves, caring for the queen and brood, tending to the fungal cultures and defending the colony.

Walter R. Tschinkel

Six architectures of ant nests of different species *Camponotus socius*, *Pogonomyrmex badius*, *Trachymyrmex septentrionalis*, *Formica Dolosa*, *Pheidole morrisi*, *Cyphomyrmex rimosus*
Tin casting

Various sizes
Courtesy Walter R. Tschinkel

Walter R. Tschinkel is a US biologist who conducts research in the field of sociobiology and behavioral ecology of social insects, particularly ants. Tschinkel's decades of work have contributed significantly to a deeper understanding of ants' way of living. He has devoted special attention to their nest architecture. His studies have revealed how ants regulate temperature and humidity within their nests.

The exhibition features XX objects from Walter R. Tschinkel's collection, which the scientist created for research institutions. The objects concerned are aluminum and zinc casts of XX underground nests. Each nest was built by a different population, all living in the same 30-hectare habitat in the sand dunes of the pine forests located on the coastal plains of North Florida. In this region, there are up to 50 different ant species living in hundreds of populations.

Walter Tschinkel's interest lies with this specific space, which he calls "the ant paradise" because it allows him to reveal biodiversity. In this limited area, ants have developed various characteristics and abilities. For example, the Florida Harvester ant has specialized in collecting plant seeds and created a quite different habitat than the tiny Pheidole Adrianoi, which lines its nest chambers with fungi. Nocturnal species can coexist with diurnal ants, specializing in different types of food; some collect caterpillar feces, while others gather dried insect parts to nourish their fungal gardens. Worker ant body sizes can vary by up to a hundredfold, as can colony sizes, meaning ants construct their nest architectures differently.

These various species share the same habitat and adapt in such diverse ways that they can coexist in an extended community.

The selection of casts in the exhibition illustrates how nature creates diversity and what exactly diversity is. At first glance, the architectures may appear different, but Tschinkel's research reveals that nest-building ants create individual variations of the same basic plan. This basic structure—a vertical shaft with one or more horizontally connected chambers—traces back to the hunting wasp from which ants evolved.

Almost all modern ant nests follow this ancestral pattern. Diversity arises from many small modifications of a basic model.

Ants are essential beings for ecosystems due to their populations' high adaptability and collective intelligence. They aerate soil, contribute to humus formation, dispose of dead organisms and parasites, distribute seeds, and cultivate fungal species in an act of symbiotic welfare. Scientists are increasingly interested in ants due to their biochemical bacterial film which protects them from diseases and fungal infections. They are true masters of recycling and logistics.

The Frankfurter Kunstverein often presents scientific specimens and artworks in shared spaces in its exhibitions. Both art and science can render insights and ideas physically experienceable through their actual manifestation. Visibility generates understanding.

Tschinkel's cavity casts create a unique bridge between scientific specimens and sculptural objects. They condense knowledge based on many years of observation and data collection. Tschinkel does not view ants solely as objects of scientific curiosity, but as fellow inhabitants and co-creators of a shared world. In the exhibition, the nest casts serve as objects of knowledge and simultaneously as matter transformed by complex life processes, beings who have existed on this planet for millions of years.

INFORMATION ABOUT THE INDIVIDUAL ANT SPECIES REPRESENTED IN THE NEST CASTS

CAMPONOTUS SOCIUS
This is the largest ant species in Tschinkel's area. When excavating their nests, the ants scatter the dug-out soil in a fan-like pattern, making their nest openings easily discoverable at the base of clumps of grass. The nests can be over a meter deep or as shallow as 30 cm, but they are always sturdy. Colonies have a single queen, who may inhabit up to 15 nests in the summer. Towards the end of the season, they abandon all but one or two nests for overwintering. The female workers usually forage individually for honeydew from aphids and mealybugs, bringing the liquid back to the nest. Like other Camponotus ants, their larvae pupate within a silken cocoon they create themselves.

POGONOMYRMEX BADIUS
One of the larger ant species found in the dry, sandy soils of the coastal plains from North Carolina to Mississippi. Their nest chambers are distinctive because the older workers in the area collect charcoal pieces and deposit them on the nest disc. The black nest disc stands out as a result from the white sand in which the nest is constructed. From April to November, older workers leave the nest at 8 am to collect seeds from up to 50 different plant species and prey insects. They deposit everything in the upper nest chambers, from where younger workers transport the collected items to lower chambers or to the larvae in the lower third of the nest. Since the seeds are too large for the ants to open, they wait for them to germinate. Germination varies depending on the season, species and soil temperature.

All ant populations exhibit strict division of labor. This is based on an ant's age and runs parallel with its location within the nest. Young workers are born in the lower third of the nest and spend the first phase of their lives caring for the brood. As they age, they move up and down the nest, performing more general tasks like food transport, seed storage and digging the chamber. They collect and transport the food brought into the nest and distribute it within the nest. Only the oldest workers leave the nest in search of food, with a remaining life expectancy of about three weeks. Within the nest, a constant upward movement of aging workers can be observed, with the older ones replacing those that die during foraging expeditions. Death occurs not primarily due to old age but because of environmental strains like heat, dehydration, or territorial conflicts.

Harvester ant nests are the largest and most intricate. They can reach depths of up to three meters and feature spiraling tunnels connecting pancake-like chambers. The chambers near the surface are densely packed and highly complex, while those at greater depths are simpler and more spaced out. Seed chambers can generally be found at intermediate depths between 40 and 100 cm. On average, a colony relocates once a year, usually in the summer. They do not move far; the new nest is typically about four meters from the old one. The new nest is similar in size and architecture to the old one, which raises the question as to why they move. Remarkably, excavating the new nest and transferring all the contents of the original nest (including seeds) to the new location takes only four to six days. Most of Tschinkel's nest casts were made from recently abandoned nests, sparing the colonies from destruction.

These colonies have remarkable longevity, reaching maturity at around 4-5 years, with a life expectancy of over 30 years. The colony's lifespan is closely tied to that of the queen, who serves as the mother of all ants throughout the colony's existence. Mating only once at the beginning of her reproductive life, she stores a lifetime supply of sperm in a small sac called a spermatheca, obtained through mating with a dozen or more males. All females develop from fertilized eggs, while males come from unfertilized eggs (as is typical all for ants, wasps, and bees).

TRACHYMYRMEX SEPTENTRIONALIS
This is one of two fungus-growing ant species in the Sandhills habitat. Its range extends to Long Island, NY, and Illinois. The workers have spiky, bulbous bodies and move slowly but are extremely numerous, with up to 1,000 populations per hectare. Nests are easy to spot because excavated sand is piled up in a crescent shape on one side of the opening. If the pile is removed, the ants will redistribute the sand in the same direction. On sloping terrain, the crescent is typically downhill. When the ants encounter a prominent landmark near their nest, they align their sand pile with it. Hence, they navigate visually. The following question remains unanswered: the sand mound is reached by workers, who obviously coordinate the orientation. How this happens has not been investigated to date.

In nests around 150 cm deep, ants cultivate their fungus in egg-shaped chambers. They allow it to grow on a substrate of plant debris and caterpillar feces. The fungus is the sole food source for these ants and their larvae.

Around October, the ants disassemble and discard their fungus gardens. As the ground warms throughout the summer, the ants dig deeper chambers and relocate their gardens, filling the higher chambers with excavated soil. Despite their small size, these ants move approximately one ton of soil per hectare per year, thus playing an important role in soil mixing.

FORMICA DOLOSA
These ants are large, dig compact nests, and primarily feed on honeydew from aphids and scale insects. Their workers are fast and agile, and can be quite aggressive. Their light coloration suggests that they are mainly active at night. Workers possess large poison glands in their jaws and can spray formic acid, which smells like vinegar, to defend themselves. However, their nests, located just below the ground's surface, are easy prey for armadillos and skunks. Some

populations tend and guard aphids and scale insects, cultivating them for honeydew. These ants then feed the harvested honeydew to other workers called "tanker" ants, which shuttle between the aphid plant and the nest. In some populations, these ants guard the aphids around the clock.

PHEIDOLE MORRISI
This species forms large colonies with up to 80,000 workers. They build mounds above their underground nests, consisting of up to four shafts with small, closely spaced side chambers. In flatwood areas, the water table limits the nest's depth. The ants and their brood are dependent on soil temperature and humidity. The population defends its boundaries against neighboring colonies.

CYPHOMYRMEX RIMOSUS
The ability to cultivate fungi as a food source has only been observed in American ants according to current knowledge. In the area Tschinkel studied, he found two species: Cyphomyrmex rimosus and Trachymyrmex septentrionalis. The former originally migrated from Argentina, where it is widespread. Fungus-growing ants feed on materials not utilized by other ants, particularly dead insects. They construct structures on which a yeast-like fungus grows, which they consume. The larvae are kept in chambers separated from the fungus gardens. Typically, the fungus grows in a filamentous form, but when ants cultivate it in gardens, it assumes a different, cell-like form.
Like most other fungus-growing ants, the workers carry multiple species of bacteria and fungi on their body surfaces, producing antibiotics to suppress the growth of parasitic fungi in their gardens.

The nest architecture of this ant species differs from its counterparts, appearing irregular, without true chambers, seemingly chaotic. The reasons behind this remain unclear, as most other ant species tend to build egg-shaped chambers to house their fungal gardens.

Mating flights occur in early summer. Males form a floating swarm with females flying in the center. Mature, winged females carry a piece of fungus from their birth nest on their mating flights. When establishing a new nest through digging, they create a structure using dead insect parts, on which they plant the fungal pieces and so start a new garden.

Maurizio Montalti

RECIPROCITY // Mogu Acoustic ASPEN Tiles, 2023
Bio-fabricated mycelium-composite acoustic tiles, grown by means of fungal fermentation on low value substrates/residues, including hemp, cotton, and mycelium biomasses
Triangle-shaped modules, each one 45,5 x 39,8 cm

RECIPROCITY // The Alchemist – Ganoderma lucidum, 2021
Fungal Biomass and fruiting Bodies/mushrooms, cultivated on agro-industrial residues, including hemp straw and sawdust
Anamorphous volume, inscribed in full volume of 75x75x45 cm

Courtesy Maurizio Montalti / Mogu

RECIPROCITY // The Lower Fungi, filmed by Wim van Egmond, 2023
Film comprising a customized montage of high-quality timelapse films portraying fungal growth and behavior, as based on high-res micro-photography
13:30 min

RECIPROCITY // Metabolic Transformation, 2023
Film still from *One Minute/Four Seconds* shot by Wim van Edgmond, commissioned 2016 for *Fungal Futures*, curated by Officina Corpuscoli / Maurizio Montalti
Macro-photography, printed wallpaper mounted on wall
420 x 260 cm

Courtesy Officina Corpuscoli/Maurizio Montalti & Wim van Egmond

Maurizio Montalti is an artist, innovation researcher and entrepreneur with an engineering background. He works at the intersection of biotechnology and for over a decade now has been pioneering the development of sustainable and forward-thinking materials.

Montalti's work revolves around a comprehensive understanding of life cycles, the interplay of becoming and decaying. He investigates various organisms and natural processes within a holistic framework of which humans are an integral part. Montalti employs methods that explore biological processes as a foundation for creating biological materials. He sees his work with fungi as representing a collaboration between humans and non-human organisms, all functioning as part of a living system. Montalti's knowledge is rooted in theoretical and speculative ideas about new forms of coexistence, which have translated into practical actions.

What is commonly referred to as a mushroom is the reproductive structure (fruiting body) of a larger living organism, the mycelium. This mycelium is mostly invisible, growing as long filamentous strands in the soil or within deceased, nutrient-rich organisms. Mycelium refers to a network of thread-like fungal filaments (hyphae) that are so fine they are invisible to the naked eye. The filament network can become so dense that it forms a compact structure.

For the exhibition *Bending the Curve*, Montalti has designed a spatial installation titled *RECIPROCITY*. The installation reveals a mycelium-created cycle of elements and transformative processes to viewers. Montalti's installation consists of different elements that expose the invisible. It includes a wall installation made of mycelium modules, a photographic close-up of mycelial threads in organic material, a film depicting the growth of mold fungi, a glass object, inside of which a substrate inoculated with mushroom spores can be seen, and with a mushroom sculpture on its top.

Montalti's artistic practice is rooted in the fact that in nature, death and decay of biological cells and bodies are prerequisites for the emergence of new life. His work emerges from this natural process and the central role that fungi play in the environment as decomposing agents. They break down dead cells and transform them into substrate to become nourishment for new life of other organisms.

The title of the spatial installation encapsulates the artist's central stance. Reciprocity means that every living being, human or non-human, is in a mutual relationship with all other living beings. Humans live in a coevolutionary interrelationship with other animals, plants, bacteria, viruses and fungi. This implies that changes and developments in species react to each other. By choosing the title of his work – *Reciprocity* – the artist references the insights of biologist and philosopher Lynn Margulis (1938 – 2011), who devoted her life and research to the evolutionary theory of symbiogenesis. This describes the emergence and development of life-communities in which different organisms closely interact and can only carry out their life-related functions in mutual dependence. Margulis conducted research on microorganisms like algae, bacteria, yeasts and fungi, which, in symbiosis with other organisms, induce changes in DNA and thus contribute to the emergence of new species.

At the center of the *Reciprocity* installation is the living sculpture, *The Alchemist – Ganoderma lucidum*. This organic sculpture consists of a grown mushroom body, a mature fruiting body that retains its shape through drying. The transparent glass base on which the sculpture stands contains substrate inoculated with mushroom spores that will develop over the course of the exhibition. It is not the sculpture that is alive, but the content of the base. This effectively reverses the way in which presentation has conventionally been prioritized in art museums. The title The Alchemist refers to the historical discipline that explored the properties of substances and their reactions, often with the goal of transforming them into valuable gold.

While plants produce their nutrients from sunlight and air through photosynthesis, fungi, like animals, derive their energy by digesting living or dead organic matter, as animals do. They grow and branch out, absorbing nutrients directly through their cell walls. The mycelium secretes enzymes that break down and absorb sugars from the material. In a natural setting, one of their primary functions is to break down dead material and organic matter, returning nutrients to the soil for plants to take up once more. The speed at which they do this plays a crucial role in how regeneration occurs in ecosystems.

Montalti views the natural decay process of fungi as a symbol for the cycle of all things and all life, in which death and decay are necessary to make room for new life forms and processes. Montalti represents an attitude held by numerous artists and innovative researchers today who produce their work with awareness of a socio-ecological transformation and their responsibility within that. The metaphor is insufficient for them: they move from metaphor into real implementation and action.

Montalti is a co-founder of the Italian company SQIM and the brands Mogu and Ephea, which produce biomaterials using mycelium through biodesign for interior design and textile production.

The start-ups are part of a transformation under way towards nature-inspired and sustainable materials and a new economy. With the Mogu company, Montalti places the idea of a partnership with non-human organisms at the center of his entrepreneurial activity. The concepts of reciprocity and co-creation are central to both his artistic work and his entrepreneurial endeavors.

Part of RECIPROCITY is the wall object consisting of mycelium modules. The acoustic panel system, triangular mycelium shapes, is produced by the artist in his co-founded start-up MOGU. The mycelium modules generate acoustic insulation due to the porous structure. The objects are biologically produced and biodegradable. By controlling humidity, temperature, substrate composition and the use of mineral pigments, different types of mycelium with varying strengths, densities and colors can be produced. With their goal of being part of an ecological transformation, Maurizio Montalti and his collaborators at Mogu have expanded the range of mycelium-based products and developed standardized production series.

The film *The Lower Fungi* and the macrophotography *Metabolic Transformation* are the result of a collaboration between microphotographer Wim van Egmond and Maurizio Montalti. Accelerated time-lapse footage of mushroom growth, observed through microscopes and stereoscopes, has resulted in high-resolution images. The macrophotography features the same type of mushroom from which the Mogu Acoustic ASPEN tiles are made.

Biomimicry, i.e., the knowledge and application of natural forms, processes and ecosystems to human actions, is a central part of Montalti's artistic practice. In 2010, he founded the multidisciplinary studio Officinia Corpuscoli in the Netherlands. Here scientists and designers research biological processes and the connection between human and non-human beings. In particular, Montalti collaborated closely with mycologists (fungus scientists) and researchers from the University of Utrecht and the Fungal Biodiversity Centre CBS to explore diverse forms of mycelium and their potential as solutions to societal challenges. Jointly with them, Montalti developed methods that harness the biological properties of mycelium to create biobased and biodegradable products as alternatives to traditional products that often environmentally harmful.

"In nature, and that's where you have to look if you want to learn something new, nothing disappears. It simply changes shape." – Maurizio Montalti

4th Floor

MYRIAD. Where we connect.

A project of Interactive Media Foundation and Filmtank, in co-creation with Miiqo Studios, Context Film and Artificial Rome

MYRIAD. Installation, 2023
Fourteen modules, five seating blocks, two seating benches made of wood, Resysta, Ytong, coated with coloured concrete
Various sizes

Interactive projection mapping on three carbon modules, floor projection, reactive multi-channel audio installation

MYRIAD. Virtual Reality Experience, 2023
Virtual Reality Application
Each story 10 min

Presentation module, one seating block made of wood, coated with coloured concrete
Various sizes

360° 3D Documentation, 2021
Stationary Virtual-Reality Station with two videos
10:09 min
Presentation module, one seating block made of wood, coated with coloured concrete
Various sizes

Source list of data used

Courtesy MYRIAD. Where we connect., Interactive Media Foundation and Filmtank, in co-creation with Miiqo Studios, Context Film and Artificial Rome

Every year, a myriad of living beings traverses our planet. Their migrations, orchestrated in regular rhythms, choreograph the life of our planet like that of a pulsating superorganism. The decisions animals make on their journeys, the ways they interact with the ever-changing environment, and the consequences of their migrations on ecosystems are all reshaping our understanding of the interdependency of all living creatures and the shared spaces they inhabit. The natural sciences explore these connections, which also resonate interpretatively in the social sciences and philosophy. Ancient stories and myths in different cultures have long told of the completeness that binds all living beings.

MYRIAD. Where we connect. is an immersive, multimedia installation at the intersection of art, science and storytelling. This walk-through, interactive project celebrates its premiere in the exhibition *Bending the Curve - Knowing, Acting, Caring for Biodiversity*, alongside the previously successful VR experience and a 360° 3D documentary. The work allows us to adopt the perspective of individual animals, taking us along on their long journeys across continents.

In the internationally acclaimed Virtual Reality experience MYRIAD. Where we connect., visitors follow the migrations of a green sea turtle, a female Arctic fox, and a group of northern bald ibises. Each journey combines scientific knowledge with moving images and visual information about the animals' routes through a world increasingly influenced by human activity.

The 360° 3D film, which is also award-winning, shows the flight of the northern bald ibises over the Alps and their successful reintegration into their natural habitat. The spectacular footage was made with the help of an ultralight aircraft.

A central element of MYRIAD. Where we connect. is carbon. Over eons of the cosmos, this fundamental element arose in the hearts of stars through the fusion of helium. It arrived on our planet from space through countless asteroid impacts, becoming the chemical building block of life. The bodies of all living beings, including plants, fungi, animals and humans, contain this element. Carbon has thus become one of the central design elements of the multimedia art installation. The visual worlds of MYRIAD. Where we connect. are based on black and white charcoal drawings, from which digital animations were created. The forms of carbon's binding structures live on in the sculptural spatial elements and their tactile, haptic surfaces. All 3D animations and elements of the multimedia installation are monochromatic. They insert fragments of knowledge and give visual artistic expression to data that has been interpreted.

The journeys of individual animals during their migrations are narrated on three large-scale carbon objects. In the overall 22-minute animation, visitors follow the flight routes of animal flocks and the stories of individual species. Amur falcons, monarch butterflies, and common cranes are featured. As one of the elements of animal migrations, air marks the beginning of the exhibition at the Frankfurter Kunstverein. Borders, obstacles, land use, as well as changes in the Earth's system and polar melting, pose significant challenges to living beings during their migrations.

Made of wood, the installation objects are coated with black-pigmented concrete putty. These materials were sonically deconstructed, captured, and used for the soundscape by means of the audio effect "Convolution Reverb". The sound characteristics and audio processing of the materials shape the atmosphere, generating novel sounds of material quality.

The sculptural elements of the spatial installation are embedded in a 360-degree soundscape. The acoustic spatial experience follows the concept of Soundscape Ecology. It orchestrates biological sounds (biophony), human sounds (anthropophony), and non-biological but sound-producing natural phenomena. The acoustic ecosystem thereby created responds to the presence of visitors in the space, symbolizing the changing influence of humans on their environment.

MYRIAD. Where we connect. was created in close collaboration with an interdisciplinary team. The representations are based on real data from over 20,000 tracked animals migrating in water, on land, and in the air. The data comes from the Movebank database, a long-term project of the Department of Animal Migration at the Max Planck Institute of Animal Behavior. MYRIAD. Where we connect. brings together current research content from the fields of animal migration, behavioral biology, climate research and infrastructure development, drawing on the Big Data of the Movebank project, among other sources. Abstracted data and information are transformed into experiences through art, creating a connection between people's imagination and awareness of the global interconnectivity of our planet's ecosystems.

MYRIAD. Where we connect. is a project of the Interactive Media Foundation and Filmtank in co-creation with Miiqo Studios, Context Film and Artificial Rome. Artistic Direction: Lena Thiele, Sebastian Baurmann and Dirk Hoffmann. Sound Design: kling klang klong.

Interactive Media Foundation gGmbH
The Interactive Media Foundation is a nonprofit organization with a philanthropic mission dedicated to developing socially relevant stories through audiovisual media formats (film, virtual reality, exhibitions). It produces and finances its projects with the help of private foundations and public funds, and carries out distribution in collaboration with various partners. Its work is based on a collaborative creative process and a broad network of partners. The Interactive Media Foundation brings together specialists from various societal areas and combines expertise, insights and techniques from different disciplines to open new, often surprising perspectives on captivating and touching topics. Its productions are showcased at media art and film festivals worldwide and in numerous cultural institutions. Recognition from experts and juries from various fields is reflected in prestigious awards such as the Federal Prize for Cultural Education, the Grand Prix of the Art Directors Club, or inclusion in the Forbes list for outstanding creativity. The Interactive Media Foundation was founded in Berlin in 2013.

Filmtank GmbH
Filmtank is a multiple award-winning production company based in Hamburg, Berlin and Stuttgart. Originally from the documentary film sector, its creators now produce entire thematic universes. Filmtank brings together old masters and young inventors to create new perspectives.

Miiqo Studios UG
Miiqo Studios was founded in Berlin in 2012 and focuses on creating immersive worlds at the intersection of art, science and storytelling. They follow a holistic approach, combining contemporary digital technologies and socially relevant stories to create emotional and touching experiences.

Context Film GmbH
Context Film has stood for sophisticated documentaries, innovative fictional storytelling and high-quality informational films since 2004, exploring diverse and complex realities of life. Their work, freely told and independent in form, breaks traditional thought patterns.

Artificial Rome GmbH
Artificial Rome is a studio for digital design and visual communication with a focus on immersive, interactive experiences. The team has been developing interactive communication formats since 2014 through the fusion of digital technology, creative vision and a clear design signature.

kling klang klong GmbH & Co. KG
The Berlin-based creative studio kling klang klong composes sounds and codes for auditory experiences. The team of composers, sound designers, creative thinkers, scientists and

technicians explores new ways to touch people through sound. Their works are present in physical and virtual environments, exhibitions, museums and events internationally.