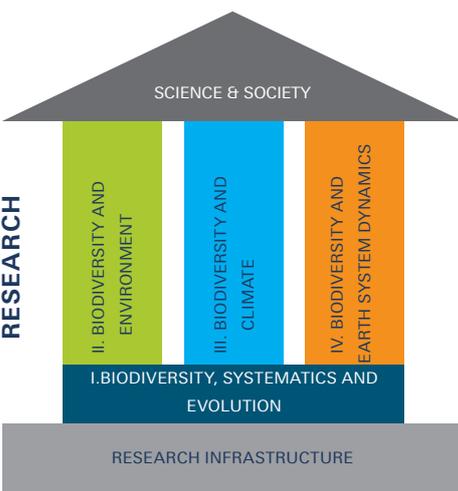




**Dear Readers,**

During the recent anniversary year of the Senckenberg Gesellschaft für Naturforschung, scientists at our eleven locations described 291 new species – from the giant fossil penguin *Kumimanu biceae* that stood more than 1.7 meters tall to the tiny dinoflagellate *Gambierdiscus lapillus* with a length of just a few millimeters. The taxonomy and the nearly 40 million objects in the scientific collections form the basis of Senckenberg’s geobiodiversity research.



While the colleagues from Görlitz were already able last February to reach their overall best monthly results since the museum’s reopening in 2003, the planning for the “New Museum” continues in Frankfurt. Currently, the “Senckenberg Project” is starting with the modular conversion of the existing building. The exhibition “Coral Reefs – The Oceans’ Threatened Treasure” (start date 8 June 2018) offers a preview of the new “Coral Reef” hall slated for opening in 2020. The new Archaeopteryx exhibition (start date 6 July 2018) will later be incorporated into the “Fossil Sites” area in the New Museum, and a simulated dive in a submarine (start date in winter 2018) whets the appetite for the newly designed “Deep Sea” hall, to be opened in the fall of 2019. Additional projects are already being planned in cooperation with various partners and are in preparation “behind the scenes.” The extension building, which will house the exhibition highlights “Walk-in Brain” and the oversized LED globe, is scheduled for the year 2022. If you would like to support the project, you can find additional information at [www.die-welt-baut-ihr-museum.de](http://www.die-welt-baut-ihr-museum.de).

Enjoy reading about the highlights from research, science, society, and infrastructure!

Dr. Sören Dürr & Judith Jördens  
Communication Staff

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**IMPRINT**

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# BIODIVERSITY, SYSTEMATICS AND EVOLUTION

## WHALE RELATIONS: THE GENETIC MATERIAL OF THE BLUE WHALE REVEALS MATING ACROSS SPECIES BOUNDARIES



Giant of the Oceans: The Blue Whale. © Florian Schulz

 Blue whales – the giants of the oceans. With a length of up to 30 meters and a weight of 175 tons, they are the world's largest animal. For the first time, scientists of the Senckenberg Gesellschaft für Naturforschung, the Goethe University and the University of Lund were able to decipher the entire genome of these gentle giants, along with three other species of rorqual whales. The whales' genome makes it possible to retrace the evolutionary history of the world's largest animal and its relatives in

great detail. Surprisingly, it has become apparent that different species of rorqual whales interbred over the course of history. Scientists used so-called network analyses to uncover the rorquals' evolution. "With this method, the origin of species is not shown as the usual phylogenetic tree but as an interwoven net. This enables us to discover otherwise hidden genetic signals," explains the evolution genomics researcher Prof. Axel Janke of the Senckenberg Research Center for Biodiversity and Climate, who is also the spokesperson for the newly founded LOEWE Research Center for Trans-

lational Biodiversity Genomics (LOEWE-TBG). Moreover, the team found out that the relations among the other rorqual whales are also more complex than previously assumed. Until now, the humpback whale was considered an outsider among the rorquals, due to the enormous size of its flippers. The study now confirms that this classic taxonomic view does not conform with evolutionary systematics. The same applies to the gray whale, which was previously not even considered part of the rorqual group. In fact, gray whales are very closely related to the other rorqual whales, but they exploited a different food source, hunting for small crustaceans near the bottom of coastal waters.

>> [Arnason, U. et. al \(2018\): Whole genome sequencing of the blue whale and other rorquals find signatures for introgressive gene flow. Science Advances, DOI 10.1126/sciadv.aap9873](#)

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## BIODIVERSITY, SYSTEMATICS AND EVOLUTION

### RESEARCHERS IDENTIFY THE GENETIC BASIS OF RAIDS CONDUCTED BY ANTS

 Barely 3 mm long, yet a veritable fighting machine – the North American ant species *Temnothorax americanus* a tough customer, since it belongs to a group of ants that enslave closely related species and make them work in their captor's colonies. The "slave ants" are tasked with brood care and food collection for the other species. Ants like *Temnothorax americanus* undertake raids in order to obtain slaves. Researchers of the Senckenberg Research Center for Biodiversity and Climate and the Johannes Gutenberg University in Mainz (JGU) examine which genes control these raids.

"Our genetic analyses show that the different attack methods result from differences in gene control," explains Dr. Barbara Feldmeyer of the Senckenberg Research Center for Biodiversity and Climate. Figuratively speaking, this occurs as follows: In the genome of the three ant species, certain buttons are pushed at different levels. Ultimately, however, all species achieve the same goal – a successful raid. This finding comes

as a surprise, since it is usually assumed that closely related, genetically similar species would employ the same genetic path to achieve a certain goal.

As evidenced by this study, it is quite possible that genetic evolution among closely related species occurs randomly. The results suggest that many evolutionary adaptations can be traced back to random mutations that lead to genetic differences even between closely related species. But since these species are often subject to similar selection pressure, the outcome of the adaptation processes, i.e., the behavior, is similar.

>> [Alleman, A., Feldmeyer, B. and Foitzik, S. \(2018\): Comparative analyses of co-evolving host-parasite associations reveal unique gene expression patterns underlying slavemaker raiding and host defensive phenotypes. Scientific Reports, DOI:10.1038/s41598-018-20262-y](#)

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Colony of the slave-owner ant species *Temnothorax americanus* with *Temnothorax longispinosus* ants that are forced to care for the host species' brood. © Barbara Feldmeyer

## BIODIVERSITY SYSTEMATICS, AND EVOLUTION

## DEEP-FROZEN SNAKE



Among the heat-loving reptiles, the grass snakes are considered rather “cool” customers, since their current range extends up to the Siberian perma-frost soils as well as around the Finnish-Russian Lake Ladoga. “However, the fact that the thermophilous snakes ‘overwintered’ in Central Europe during the Pleistocene Ice Age came as a massive surprise to all of us,” explains Dr. Uwe Fritz of the Senckenberg Natural History Collections in Dresden.

To date, it had been assumed that heat-loving reptiles survived the Ice Ages on the southern peninsulas in Europe and spread northward again during the Holocene or during the interglacial periods, when temperatures began to rise. Using genetic methods, Fritz, his doctoral student Carolin Kindler and her Spanish colleague Eva Graciánow discovered that not all of the snakes, which today occur widespread across Europe, retreated to warm, Mediterranean regions.

In the context of the study, the team examined a total of 1,372 data sets concerning these reptiles, which pose no danger to humans. “In the process, we studied various genetic lineages of the barred grass snake (*Natrix helvetica*) and the eastern common grass snake (*Natrix natrix*,” explains Kindler, and she continues, “One of the lineages of *Natrix natrix* survived the Ice Age in two separate refugia – one in the Southern Balkans, the other – quite unexpectedly – in Central Europe.”



Today, grass snakes are widespread across Europe and even occur in Siberia. © Senckenberg / Vamberger

To prove these theories, the scientists, among other things, point to the much higher diversity of the grass snakes in Northern Germany and Scandinavia, compared to their southern relatives.

“The model of ‘warm refugia’ – retreats in the Mediterranean region – during the Ice Age should therefore be reexamined. It is quite possible that other heat-loving animals also withstood the cold temperatures right in their home range,” adds Fritz in closing.

>> Carolin Kindler, Eva Graciá & Uwe Fritz (2018): Extra-Mediterranean glacial refuges in barred and common grass snakes (*Natrix helvetica*, *N. natrix*), *Scientific Reports* volume 8, Article number: 1821 (2018) DOI:10.1038/s41598-018-20218-2

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## BIODIVERSITY, SYSTEMATICS AND EVOLUTION

## WATER TREADERS IN AMBER



Long-legged water treaders that elegantly moved across the water’s surface – they probably already existed during the age of the dinosaurs in the Cretaceous. However, these insects are rarely represented in the fossil record. Their slender limbs are too delicate to be preserved undamaged during the fossilization process. Preservation in petrified resin is also unlikely since the water-loving animals are rarely found in the vicinity of resin-producing trees.

Mónica M. Solórzano Kraemer of the Senckenberg Research Institute in Frankfurt, together with a Spanish-French team, discovered two previously unknown species of water treaders in Spanish amber. “We have newly described two males and one female from the bug family Mesoveliidae, which were enclosed in a piece of amber from the fossil site of Peñacerrada in Northern Spain,” explains the amber researcher from Frankfurt, and she continues, “The discovery

dates to the Cretaceous, which makes it the oldest documented discovery of this group of insects known to us.” Due to the presence of several individuals in the amber, the research team further assumes that these insects with their delicate limbs lived in communities. “The discovery is the earliest documentation of such ‘aggregative behavior’ in geological history,” adds Solórzano Kraemer.



A rare find: The new species of water treader, enclosed in Spanish amber. © Senckenberg

The identification of the new species could only be accomplished through the use of an infrared microscope at the Department of Paleontology and Historical Geology of the Senckenberg Research Institute. Although the Spanish amber is relatively light and translucent, air enclosures and the dark coloration of the encased animals impeded the identification. “Our infrared microscope offered us a non-destructive method to observe even the smallest details of the animals trapped in the amber,” says Solórzano Kraemer.

>> Sánchez-García A, Nel A, Arillo A, Solórzano Kraemer MM. (2017): The semi-aquatic pondweed bugs of a Cretaceous swamp. *PeerJ* 5:e3760 <https://doi.org/10.7717/peerj.3760>

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# BIODIVERSITY AND ENVIRONMENT

## GERMAN WILDCATS KEEP TO THEMSELVES



Due to their shy habits, it is very difficult to observe wildcats in nature and distinguish them from tiger-striped domestic cats. Mathematically, in Germany there are more than one thousand domestic cats for each wildcat. "It could therefore be assumed that wildcats and house cats frequently encounter each other and also mate," explains Annika Tiesmeyer, a doctoral student at the Senckenberg Research Institute and the Goethe University in Frankfurt.

The mating of domestic cats and wildcats results in so-called "mongrels" or hybrids that continue to be fertile. In the worst-case scenario, over time the native wildcat could even become extinct due to permanent crossing with domestic cats. And this is already the case in certain regions of Europe: In Scotland, there are most like no pure wildcats left; the entire population consists of hybrids between domestic and wildcats. In Switzerland and France, 12 percent of samples revealed traces of both wild and domestic cats in the genome, as shown by a recently published study.

In the light of these findings, the results obtained by the animal geneticists from Senckenberg come as a particular surprise. "We examined 1,071 wildcat samples from all over Germany that were sent to us by our



Prefers to keep to its own – the wildcat. © Steyer

cooperation partners, such as the BUND. Only 37 of the examined animals showed evidence of hybridization. Thus, in Germany we have one of the lowest hybridization rates in Europe," summarizes Dr. Katharina Steyer, who studied wildcats as part of her doctoral research at the Senckenberg Research Institute and the Goethe University in Frankfurt.

Researchers are not yet able to explain why the more than 10 million domestic cats in German households so rarely mate with the estimated 5,000 to 10,000 wildcats. Tiesmeyer explains: "Wildcats and domestic cats certainly meet along the edges of forests – we know this due to hair trap studies. However, hybridization apparently occurs mainly in areas where wildcats are still in the process of spreading and wild mates

are hard to find."

The scientific findings regarding the degree of hybridization are of significant importance for the long-term protection of wildcats. Besides the progressive habitat loss and ever-increasing traffic density, hybridization – i.e., the mixing of domestic and wildcats – had been considered the main threat to wildcats until now.

>> Steyer K, Tiesmeyer A, Muñoz-Fuentes V, Nowak C. Low rates of hybridization between European wildcats and domestic cats in a human-dominated landscape. *Ecol Evol.* 2017;00:1–15. <https://doi.org/10.1002/ece3.3650>

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### BIODIVERSITY AND ENVIRONMENT

## IN THE VICINITY OF HUMANS, ANIMALS TEND TO MOVE LESS



Whether long-distance runners such as the zebra or short-distance sprinters like the hare: All mammals conduct daily movements over short or longer distances, among others in search of food. A team of scientists around biologist Dr. Marlee Tucker of the Senckenberg Research Center for Biodiversity and Climate and the Goethe University were now able to show that the activity range of mammals significantly decreases in areas with a strong human influence. Here, terrestrial mammals on average cover only about one-third of the distances that they would traverse in undisturbed natural habitats.

In the most comprehensive study regarding this topic to date, Tucker and 114 co-authors analyzed the movements of 803 individual mammals around the globe. "We examined a total of 57 mammalian species, from hares and wild boars to elephants. Researchers in the team equipped each animal with a transmitter. By means of GPS we were subsequently able to hourly track the animals' whereabouts over a period of two months," explains Tucker. All data from the research-

ers' world-wide study sites were ultimately collected in the "Movebank" portal that archives animal movements. The scientists then compared the data to the "Human Footprint Index" of the areas where the animals roamed. The index shows the extent of human impact on an area, e.g., changes due

to the construction of settlements, traffic routes, or agriculture.

In areas with a comparatively high "Human Footprint Index" such as a typical German agricultural landscape, in ten days the local animals only covered around 33 to 50 percent of the distances covered on >>



Mammals (pictured are bears on a road in Poland) clearly move less in areas that are heavily impacted by human activity than in the wilderness. © Adam Wajrak

average by other mammals in undisturbed natural habitats. This applies both to the maximum distance covered in ten days as well as the average distance traveled during this period. In addition, the analysis revealed that the animals do not become slower but change their long-term spatial use behavior in such a way that they cover shorter distances over longer temporal scales. It is possible that the mammals move less since they have adapted their behavior to

the heavily human-impacted environment. "Some of these areas offer a higher supply of food; thus, the animals no longer need to travel long distances to find enough to eat. Moreover, roads and habitat fragmentation restrict the animals' movements in many places," says study participant Prof. Thomas Müller of the Senckenberg Research Center for Biodiversity and Climate and the Goethe University in Frankfurt.

>> Tucker, M.A. et al. (2018): Moving in the Anthropocene: Global reductions in terrestrial mammalian movements. *Science*, DOI: 10.1126/science.aam9712

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BIODIVERSITY AND ENVIRONMENT

INSECT DIE-BACK: EVEN COMMON SPECIES ARE BECOMING RARE



Insect numbers continue to drop – in certain regions, a dramatic decrease of up to 75 percent has been documented in recent decades. "Until now, we assumed that the species die-back primarily affected the specialists among the insects, i.e., animals that depend on a particular habitat," explains Prof. Dr. Thomas Schmitt, director of the Senckenberg German Entomological Institute in Münchenberg, and he continues, "In our current study we are able to show that even so-called "generalist species" will

face massive threats in the future." In their study, the team of scientists reveals that species with low habitat requirements depend on an exchange between different populations. "Our investigations clearly illustrate that widespread species have a notably more diverse intraspecific gene pool than species that depend on a specialized habitat," explains Dr. Jan Christian Habel of the Technical University in Munich, and he continues, "Once – due to the 'islandization' of their habitats – the animals no longer have the opportunity to maintain this genetic diversity by means of exchange, they will lose their adaptability to changing environmental conditions in the future."

"In terms of practical nature conservation, these results mean that in the future it will no longer be sufficient to preserve small, isolated reserves – while these are beneficial for a few specialized species with a simple genetic structure, the majority of species that depend on an exchange between local populations will be lost in the mid- to long term," predicts Schmitt, and he adds in closing, "This leads to an additional decrease in numerous insect species – with dramatic consequences for entire food webs and ecosystems."



The pearly heath *Coenonympha arcania* (cover picture) may be facing a difficult future – even though it belongs to a "generalist" species © Senckenberg / Schmitt

The entomologists from Munich and Münchenberg refer to this as a "temporal shift of potential causes of the species die-back." Initially, mainly insects that specialize in a certain ecosystem, e.g., the Apollo butterfly (*Parnassius apollo*), are threatened by the loss of valuable high-quality habitats. But over time, and with the continued deterioration of habitats and the breakdown of habitat networks, the threat to widespread "generalist" species such as the pearly heath (*Coenonympha arcania*) will also increase.

>> Jan Christian Habel, Thomas Schmitt (2018): Vanishing of the common species: Empty habitats and the role of genetic diversity, *Biological Conservation*, Volume 218, 2018, Pages 211-216, ISSN 0006-3207, <https://doi.org/10.1016/j.biocon.2017.12.018>.

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BIODIVERSITY AND ENVIRONMENT

GOOD-BYE HOMELAND: UP TO 16 % OF ALL ANIMAL AND PLANT SPECIES ARE POTENTIAL EMIGRANTS



Non-native animal and plant species are on the rise across the world. From 2000 until 2005, the worldwide number of records of non-native species has reached a new high, with an upward tendency. Since certain species have the potential to become a problem, the European Union is attempting to implement counter-measures by drawing up a list of the 49 most aggressive newcomers. However, this approach, which targets well-known non-native species, may fall short of its goal, as determined by an international team of researchers.

As the study's leader, Dr. Hanno Seebens of the Senckenberg Research Center for Biodiversity and Climate, explains, "28 percent of the non-native animal and plant species newly registered in a country between 2000 and 2005 were previously undocumented newcomers. These are species that have shown up for the first time outside their original range on a worldwide scale. Therefore, they are not actually represented on the EU list as such." Despite the dramatic increase over the past 150 years, the percentage of new non-native species among the regionally newly registered non-native species has remained almost the same. >>



The Egyptian goose (*Alopochen aegyptiaca*) is a newcomer from Africa, which has become well-established in Central Europe in recent decades. © Tim Blackburn

Therefore, no reduction of the biological newcomers is in sight.

This was documented by the analysis of a global data set with approx. 46,000 entries of observations of non-native animal and plant species. The data roughly cover the last 500 years – a period during which humans increasingly explored and developed even the most remote regions. And it is these newly created roads, shipping and flight routes that today facilitate the human-aided, intentional or unintentional import of

animal and plant species into new regions. A model based on the comprehensive data set also indicates that an end to the arrival of new non-native species cannot be expected anytime soon. The team of scientists calculated that between one and 16 percent of all existing animal and plant species have the potential to settle outside of their native home. The lowest potential is shown by mollusks such as snails and clams, while mammals reveal the largest potential.

>> Seebens, H. et al. (2018): Global rise in emerging alien species results from increased accessibility of new source pools. *Proceedings of the National Academy of Sciences*. DOI: 10.1073/pnas.1719429115

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BIODIVERSITY AND ENVIRONMENT

FLORAL SNAIL MAIL



The "banana slug" *Ariolimax columbianus* reaches Europe in a bouquet of flowers. © Benjamin Reise



A bouquet of flowers makes a pretty present – and to add more volume to the bouquet, salal is often used as decorative foliage.

"However, this handsome 'filler' from the genus *Gaultheria* can pack a punch," explains Dr. Heike Reise of the Senckenberg Natural History Museum in Görlitz, and she continues, "We have discovered that with the import of salal (*Gaultheria shallon*) unwanted passengers may also reach Europe."

In the course of the long-term project "Synanthropic snails and slugs," the malacologist from Görlitz, along with an international team, examined several species that were found in various Swedish flower shops among or in close vicinity of deliveries of salal. These involve the non-native snail species *Ariolimax columbianus* and *Prophysaon foliolatum* – both the plant and the snails originate from the North American Pacific coast.

Due to its size and yellowish color, the slug *Ariolimax columbianus* also known as "banana slug;" with a length of 25 cm, it is the largest terrestrial snail in North America. In addition, banana slugs are known for their unusual mating behavior: During approx. five percent of all mating acts, following the transfer of the sperm packets one of the sex partners uses its radula (rasping tongue) to bite off the other partner's penis while its still inserted in the vagina and eats it. "The slug species *Prophysaon foliolatum* has now been documented in Europe for the first time," explains Reise. Its ability to self-amputate its rear abdomen gave rise to the nickname "tail dropper."

Both species primarily live on the ground in wet coastal forests along the North American West Coast. "That is the same place where salal thrives as a lush undergrowth, and it is harvested in the forests in huge quantities. We assume that the snails are

occasionally picked up and packaged in the process. Our own, as well as other, discoveries of these snails are always made in connection with green filler plants – which supports our hypothesis," adds the scientist from Görlitz. The inadvertent import is favored by the plants' "slug-friendly" transport and storage conditions.

While many terrestrial snails from Europe have already established successful populations in North America, such as the red slug (*Ariolimax rufus*) or the leopard slug (*Limax maximus*), an import in the opposite direction has been poorly documented to date. "To counteract an invasion of these animals, we recommend increased controls in the future along the transport route indicated by us. While this already happens quite diligently in the US and Australia, Europe has a lot of catching up to do in this regard. And while these examined species are relatively large and obvious, it can be assumed that many smaller organisms find their way into Europe unnoticed along this route," adds Reise in closing.

>> Proschwitz, T. von, Reise, H., Schlitt, B. & Breu-gelmans, K. (2017). Records of the slugs *Ariolimax columbianus* (Ariolimacidae) and *Prophysaon foliolatum* (Arionidae) imported into Sweden. *Folia Malacologica* 25: 267–271.

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## BIODIVERSITY AND CLIMATE

### THE USE OF BIOMASS HALVES THE AMOUNT OF CARBON STORED BY PLANTS



Plants store carbon, which makes them an important climate factor. The effects of clearcutting forests for conversion to farmland on the earth's carbon balance are rather well-quantified. The effects of other land-use practices, however, have only been poorly studied to date. For the first time, an international team of scientists now calculated for all types of land use how they affect the carbon volume stored by plants.

According to their analysis, plants in terrestrial ecosystems currently store about 450 billion tons of carbon worldwide – significantly less than potentially possible. “In a hypothetical world without land use, the vegetation would store twice as much carbon,” explains Dr. Thomas Kastner of the Senckenberg Research Center for Biodiversity and Climate, one of the study's participants.

Roughly half of the difference between the potentially and actually stored carbon volume results from the clearcutting of forests and other changes in land cover (53-58 %), while the other half is due to the effects of forestry and the grazing of natural grasslands (42-47 %), two thirds of which can be attributed to forestry. The study shows that the effects of forestry and pasture farming on the volume of carbon stored by plants are drastically underestimated. Managed forests store about one third less carbon than undisturbed natural forests.

The results are highly controversial in regard to the current climate policy. This policy envisages an increased use of biomass in order to reduce global warming. However, this may turn out to be a trap: While biomass as a raw material replaces fossil resources in the energy supply, its use may cause the emission of significant amounts of greenhouse gases from the farmed areas. This is supported by the fact that the latter case



The use of biomass by humans halves the volume of carbon stored in the global vegetation cover.

© Biodiversity Exploratory / Jörg Hailer

occurred prior to 1880 – i.e., before the industrialization with its emissions from fossil energy sources – as documented by historical data.

The authors also identify an additional problem, since there are still significant uncertainties and data gaps regarding the protection of carbon stocks in the vegetation. “At this time, we are only able in temperate climate zones to show with sufficient certainty whether reforestation and other measures increase the biomass stock. However, in this region, the achievable effects are rather minor. Tropical forests hold the largest potential, yet to date, it has been difficult to prove that the volume of biomass increases. Therefore, improved monitoring is required in order to achieve an optimal cost-benefit

ratio for the measure,” adds Kastner in conclusion.

>> Erb, K.-H. et al. (2017): [Unexpectedly large impact of forest management and grazing on global vegetation biomass. Nature, doi; DOI:10.1038/nature25138](https://doi.org/10.1038/nature25138)

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#### BIODIVERSITY AND CLIMATE

### PARTNER SWAPPING AS A SURVIVAL STRATEGY – LICHENS ADAPT TO THE NEW CLIMATE BY CHANGING THEIR ALGAE



Lichens are the classic representatives of a symbiosis – living communities in which organisms work together in order to survive. Researchers from Frankfurt have now discovered that the alga plays a decisive role in the lichen-forming fungus's ability to cope with various climate conditions. Prof. Imke Schmitt of the Senckenberg Research Center for Biodiversity and Climate-

comments as follows: “We were able to show that the lichen-forming fungi *Lasallia pustulata* and *Lasallia hispanicalive* in symbiosis with different green algae from the genus *Trebouxia*, depending on the location. Each location has a different climate. Therefore, it stands to reason that the exchange of algal partners is a mechanism employed by the lichen-forming fungi to adapt to different climatic conditions.”

The team studied the algae's symbiotic communities in both lichens, using molecular-biological high-throughput methods to find out where exactly each fungus cohabits with each algal partner. According to Schmitt, the analysis of the green algae's approx. 23 million DNA sequences generated in this process shows that “the lichen-forming fungi could theoretically cohabit with seven different *Trebouxia* species >>

– but they do not do this everywhere. There are both “fair-weather” algal partners for warm, frost-free environments as well as “bad-weather” partners for high elevations.”

But it is not only the climate that determines which alga is used – the fungal partner has certain preferences as well. When both species, *Lasallia pustulata* and *Lasallia hispanicalive*, occur in the same location and several species of algae are also present there, one alga is used preferentially by one of the fungus species, while the other fungus uses a different alga – even though several species of *Trebouxia* can be exchanged freely among both fungus species.

If it is true that lichens are actually able to adapt to the climate through the choice of their algal partners, they would have an advantage over other organisms. “It is possible that the lichen-forming fungus might be able within just a few generations to live with a new species of alga that is better ad-



Symbiotic community of green alga (upper green layer) and fungus – the lichen *Lasallia pustulata*. © Francesco Dal Grande

apted to the new environmental conditions than the previous one,” explains Schmitt, and she adds, “This would be a significantly faster method than to adapt to new climate conditions by changes in the genome. This “classic method” can take several million years.”

>> Dal Grande, F., Rolshausen, G., Divakar, P. K., Crespo, A., Otte, J., Schleuning, M. and Schmitt, I. (2017), Environment and host identity structure communities of green algal symbionts in lichens. *New Phytol.* DOI:10.1111/nph.14770

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BIODIVERSITY AND CLIMATE

MOSQUITO HUNT IN THE CEMETERY



Asian bush mosquito *Aedes japonicus* after a blood meal. © James Gathany/CDC



Our native mosquitoes are no longer alone. For years, their populations have been augmented by exotic invaders. One of these newcomers is the Asian bush mosquito (*Aedes japonicus japonicus*), which was first recorded in Germany in 2008. Today, it can be found in Baden-Wuerttemberg, Rhineland/Palatinate, Hesse, North Rhine-Westphalia, Lower Saxony, and Bavaria.

“Experiments in the lab show that these mosquitoes can transmit the pathogens that cause Japanese encephalitis or the West Nile virus,” explains biologist Friederike Reuß of the Section for Molecular Ecology at the Senckenberg Research Center for Biodiversity and Climate in Frankfurt am Main. Therefore, from now on the Asian

bush mosquito is being monitored in Hesse by the scientists from Frankfurt.

Financed by the Specialist Center for Climate Change (FZK) of the Hessian State Office for Nature, Environment and Geology (HLNUG), the scientists set a total of ten traps on the Bierstadt and South cemeteries in Wiesbaden, the Dorndorf cemetery in Dornburg/Westerwald, the New Cemetery in Hadamar and the cemetery in Lorchon the Rhine. Their goal is to find out how many Asian bush mosquitoes move through these regions over the course of a year.

The small white fabric barrels with black nozzles pretend to be living objects ready to be bitten by exuding carbon dioxide and fragrant substances. The mosquitoes are then sucked into the trap via a ventilator. Once

the mosquito has entered the barrel, it is unable to leave. Additional small containers with stagnant water are meant to offer insights into the mosquitoes’ egg-laying behavior.

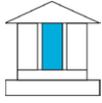
The first mosquito traps were put into operation by the scientists from Frankfurt in late October. In the winter, they are emptied twice a month, and weekly in the summer, and their contents are analyzed in Frankfurt. Besides Asian bush mosquitoes, a number of additional mosquito species as well as other insects get caught in the traps. The adult mosquitoes and their larval stages are identified and counted in the lab – for a good reason: “Our knowledge of how many Asian bush mosquitoes hatch and fly at what times is a prerequisite for potential containment measures,” explains Reuß.

A potential natural control agent is currently being tested by the team in a separate project that is also financed by the HLNUG’s FZK. In certain locations, drops of clove oil are added to the stagnant water in the egg-laying containers. This is meant to kill existing larvae. The research will show whether a large-scale application is feasible.

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## BIODIVERSITY AND CLIMATE

## MORE IS POSSIBLE: EUROPEAN FORESTS DO NOT YET LIVE UP TO THEIR FULL POTENTIAL



Forests fulfill numerous functions: They produce timber, store carbon dioxide in the soil and in tree trunks and offer habitat for a wide diversity of animal and plant species. When managing a piece of woodland, one or two of these overarching ecosystem functions are usually at the center of attention. "Timber production and nature conservation are opposing goals, according to a common assumption. When trees are planted very densely in order to maximize the yield of a forest, this can have a negative effect on the diversity of plants in the undergrowth and the birds that live there, ultimately affecting nature conservation," explains

Dr. Peter Manning of the Senckenberg Research Center for Biodiversity and Climate. "However, we were able to show that the success of one ecosystem function at the detriment of another is the exception rather than the rule in European forests."

Manning and his colleagues determined this by taking an inventory in six forest regions in Finland, Poland, Germany, Romania, and Italy. The team measured and correlated 28 ecosystem processes and services that are important for timber production, climate regulation, and species diversity. The project is one of the most comprehensive studies regarding the functionality of forest ecosystems at the European level to

date.

"As a whole, the individual ecosystem functions actually support each other. For example, if many trees are planted in a forest, these trees store carbon dioxide, thus contributing to climate regulation," explains Dr. Fons van der Plas, a researcher at the University of Leipzig who conducted the study during his time at the Senckenberg Research Center for Biodiversity and Climate. The study further shows that a large yield in timber production and the associated improved climate regulation may even go hand in hand with a high species diversity in the same forest.

However, these potential synergies are currently not sufficiently utilized by forest managers. The researchers only identified a small number of forests in Europe where different ecosystem processes important for timber production, climate regulation or species diversity reached high levels at the same time. Compared to these areas, most forests only reached about half of their potential maximum levels.

The researchers urge putting the current forest management practices to the test. Using new strategies, many ecosystem processes could be maximized simultaneously, and the existing potential of European forests could be used more efficiently.



The potential of European forests to simultaneously produce a large volume of timber as well as providing climate and nature protection is not fully used to date. © Gustav Gullstrand / Unsplash

>> [van der Plas, F., Ratcliffe, S., Ruiz-Benito, P. et al. \(2017\): Continental mapping of forest ecosystem functions reveals a high but unrealized potential for forest multifunctionality. Ecology Letters. DOI 10.1111/ele.12868](#)

## Contact

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# BIODIVERSITY AND EARTH SYSTEM DYNAMICS

## THE FOURTH IMPROVES YOUR SIGHT: FOUR-EYED FOSSIL REPTILE DISCOVERED



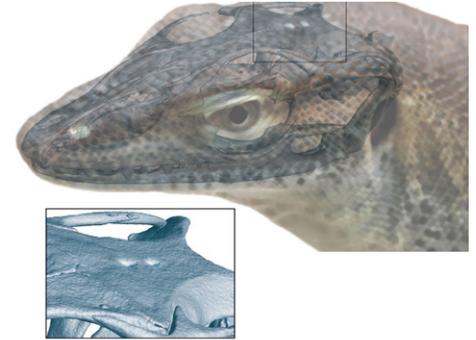
Many lizards, including the endemic Tuatara from New Zealand, have a parietal eye, also known as the “third eye” or parietal organ. “A parietal eye was a regular feature among the vertebrates of the Paleozoic more than 250 million years ago,” explains the study’s leader, Dr. Krister Smith of the Senckenberg Research Institute in Frankfurt, and he continues, “To date, the history of the parietal eye appeared to be rather simple. We assumed that in the course of evolution, this organ regressed in all higher vertebrates, except in the lizards.” This regression went hand in hand with a functional change of the pineal gland.

However, based on the recent findings by the team from the US and Germany led by Smith, this appears not to have been the case. The fossil monitor *Saniwaensidens* examined by the researchers even possessed an additional, primitive fourth visual organ behind its third eye.

The fossil monitor from the Eocene in North America is approximately 49 million years old and reached a length of up to 1.30 meters. On its head, the two additional sensory organs are arranged in a row along the center line on top of the skull. The position of these two eyes contradicts the classic paired model of the pineal gland.

“We therefore assume that the usual “third eye” in lizards is not related to the pineal gland. While the pineal gland, which gave rise to the fourth eye, is still present in lizards, it is located on the inside of the skull, as is the case in mammals,” explains Smith. Therefore, the researchers refer to a “revolution” in their study – the recurrence of already disappeared traits after a long period of time. “A comparable event would be the sudden recurrence of teeth in modern birds,” adds Smith.

The special development of the visual organs in lizards also has consequences for future research. Smith comments as follows: “It has become evident that the evolution of these two organs – the pineal gland and the parietal eye – is much more complicated than previously thought. We think that lizards occupy a special position in the development of the eyes; therefore, they should no longer serve as model organisms for other vertebrate species.”



A fourth eye was discovered in a fossil monitor. © A. Lachmann / Senckenberg / Digimorph.org

>> Krister T. Smith, Bhart-Anjan S. Bhullar, Gunther Köhler & Jörg Habersetzer (2018): The Only Known Jawed Vertebrate with Four Eyes and the Bauplan of the Pineal Complex. *Current Biology*, DOI <https://doi.org/10.1016/j.cub.2018.02.021>

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### BIODIVERSITY AND EARTH SYSTEM DYNAMICS

## MODERN MAN VS. GIANT ANIMALS



Today, there are only few animals that weigh in at a ton or more. Elephants, hippopotamuses and rhinoceroses are among these “mega-herbivores,” and despite their large size, their populations are endangered. “Under geological aspects, the small number of so few large animal species presents an anomaly,” explains Professor Dr. HervéBocherens of the Senckenberg Center for Human Evolution and Palaeoenvironment at the University of Tübingen. The biogeologist from Tübingen now examined the reasons for the extinction of these colossal animals, including giant sloths, woolly rhinoceroses and mammoths, around 12,000 years ago, and the consequences for the environment.

“Like modern-day elephants, these mega-herbivores acted as ‘ecosystem engineers.’ They reduced the tree cover and kept open the landscape and the watering holes that are of vital importance for many animals. Plant seeds were transported over many kilometers in the animals’ digestive tract,



Extinct mega-herbivores: the American mammoth. © Senckenberg

thus aiding in their distribution,” explains Bocherens.

In his recent study, he shows that these tasks were taken over in part by >>

modern humans in the period between 45,000 and 12,000 years ago. "During this epoch, modern man spread across northern Eurasia, North and South America and Australia, and the giant herbivores gradually became extinct," adds Bocherens.

With the "Neolithic revolution," the rise of agriculture and animal husbandry, the keeping of stores and a sessile lifestyle, the functions of the extinct "ecosystem engineers" were partially replaced. But in certain areas such as the agriculturally ill-suited Subarctic – once home to the mammoth steppe – there remained a gap in this respect that continues until today. The lifestyle of these giant animals impacted the entire vegetation – trees were kept small and other plants had sufficient room and nutrients for their growth. The diversity of the flora, in turn, had a positive effect on the faunal di-

versity.

Following the extinction of the giant herbivores, the steppes turned into boreal coniferous forests. This led to a reduction of the so-called "albedo effect": Instead of a white layer of snow in the winter or a yellow landscape with dry grasses in the summer, the forests' dark green color reflects less solar radiation, leading to a warming of the climate. Moreover, the soils of the mammoth steppe were drier and emitted less of the greenhouse gas methane. Bocherens comments, "The presence of giant herbivores thus not only contributed to a higher species diversity, it also had an effect on the global climate."

>> Bocherens H (2018): *The Rise of the Anthroposphere since 50,000 Years: An Ecological Replacement of Megaherbivores by Humans in Terrestrial Ecosystems?* *Front. Ecol. Evol.* 6:3. doi: 10.3389/fevo.2018.00003

Contact

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#### BIODIVERSITY AND EARTH SYSTEM DYNAMICS

### ANCIENT PREEN OIL: SCIENTISTS FIND 48-MILLION-YEAR-OLD LIPIDS IN A FOSSIL BIRD



48-million-year-old bird skeleton from the Messel Pit with uropygial gland (marked), © Senckenberg



Birds spend a large amount of time preening their plumage. In this preening ritual, the uropygial gland, located at the lower end of the bird's back, plays an important role. It produces an oily secretion used by the birds to grease their plumage in order to render it smoother and water-repellent.

Together with a group of international colleagues, Dr. Gerald Mayr, head of the Ornithology Section at the Senckenberg Research Institute in Frankfurt, now discovered the oldest occurrence of such preen oils in birds known to date. With an age of 48 million years, this ancient preen oil constitutes a small scientific sensation. "The discovery is one of the most astonishing examples of soft-part preservation in animals. It is extremely rare for something like this to be preserved for such a long time," says Mayr.

The organic materials that the soft parts consist of usually decompose within decades, or even just a few years. Several-million-year-old feathers and fur remnants are only known from a small number of fossil sites to date, including the oxygen-poor oil shale deposits of the Messel fossil site. This site also gave up the uropygial gland and the contained lipids examined in the course of this study. "As shown by our detailed chemical analysis, the lipids have kept their original chemical composition, at least in part, over a span of 48 million years. The long-chain hydrocarbon compounds from the fossil remains of the uropygial gland can clearly be differentiated from the oil shale surrounding the fossil," explains Mayr. The analysis offers proof that the fossil artifact constitutes one of the oldest preserved uropygial glands – something Mayr had already

assumed based on the arrangement in the fossil bird skeleton, but which only could be confirmed now.

To date, it is not clear why the lipids from the uropygial gland were able to survive for so long. It is possible that they hardened into a type of waxy shell under exclusion of oxygen, protecting them from decomposition. In addition, the researchers assume that one of the properties of the preen oil played a role that is still evident in modern birds today – its antibacterial components. They may have been the reason that after the bird's death only few bacteria were able to settle in, preventing the full-on decomposition.

For Mayr and his colleagues, the discovery constitutes a milestone for paleontologists. "If we find more of these lipids, we will be able to better reconstruct the lifestyle of these animals. For example, it would be interesting to find out whether feathered dinosaurs, as the ancestors of birds, already possessed uropygial glands and preened their plumages," adds Mayr in closing.

>> O'Reilly, S., Summons, R., Mayr, G., Vinther, J. (2017): *Preservation of uropygial gland lipids in a 48-million-year-old bird.* *Proceedings of the Royal Society B*, DOI: 10.1098/rspb.2017.1050

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## BIODIVERSITY AND EARTH SYSTEM DYNAMICS

THE HISTORY OF HUMANITY DOES NOT HAVE TO BE REWRITTEN:  
THE "CASE OF UNTERMASFELD"

Saber- and dirk-toothed cats, giant hyenas, hippopotamuses and elephants – the Untermassfeld fossil site in the Thuringian Werra Valley offers a unique representation of the time period around one million years ago. A recently published study in the "Journal of Human Evolution" now announced a new "sensational discovery" from the Thuringian fossil site. The study's authors describe several bones that were "processed with tools by humans." This is taken as proof for the presence of early humans in Central Europe around one million



Left and center (a, b) –Lower part of the stolen bone specimen (which was returned via an anonymous package) (rectangle, cf. Fig.1) and associated upper part, left behind by the dig robbers. Views from front and back. Right (c) – Stolen and retrieved parts of the specimen, combined with parts unearthed by Senckenberg.

years ago, according to the study's senior author, a hobby collector from Hesse.

"We have been digging in Untermassfeld since the 1970s, with a cumulative total of 90 months of recovery activity. More than 30 researchers from 20 institutes in Germany and abroad are involved in the analysis of our discoveries and results. None of us has ever before encountered traces of fossil hominids," cautions Kahlke. For the Ice Age researcher from Weimar, this was sufficient reason to get to the bottom of this asserted claim, together with a German-Dutch team of archeologists, including Professor Dr. Wil Roebroeks (University of Leiden), Professor Dr. Sabine Gaudzinski-Windheuser (University of Mainz), and Professor Dr. Michael Baales (University of Bochum).

"The archeological studies clearly show that the described bones and rocks neither constitute human tools, nor do the objects reveal signs of processing," explains Kahlke. Upon closer inspection, the marks on the fossil animal bones that were described as signs of cutting and hammering caused by humans turned out to be "the results of root etching, feeding signs by predators and rodents, as well as improper retrieval," according to Gaudzinski-Windheuser.

In addition, the team of scientists was able to prove that the 'archeological specimens' were obtained by the senior author through questionable means. They also refuted the author's claim that the objects came from an "old GDR collection." "We diligently documented the excavation in Untermassfeld with daily photographs; therefore, we can state with certainty that the 'analyzed' fossils were only broken out of the excavation surface in the period between 2009 and 2012 and thus cannot originate from an old collection," adds John-Albrecht Keiler, the Senckenberg excavation leader in Untermassfeld.

The team of scientists from Weimar links

the described objects to a series of thefts between 2002 and 2012 at the fossil site – this assumption is primarily based on a fossil fallow deer bone, which found its way into the Senckenberg Research Station's collection by way of an anonymous mailing via the Natural History Museum "Schloss Bertholdsburg Schleusingen." Kahlke comments as follows: "Among others, this bone fragment is presented as part of the archeological study refuted by us – and it was demonstrably stolen from our excavation in 2009." All in all, about 400 specimens with a potential six-figure total value were taken. With the support of the Free State of Thuringia, these specimens shall now be made available to science again. "Following the series of thefts, we have significantly expanded our safety concept in cooperation with the police agencies. We hope that illegal excavations and the resulting faulty scientific 'findings' will now be a thing of the past," offers Kahlke in conclusion.

>> Roebroeks, W., Gaudzinski-Windheuser, S., Baales, M. et al. *J Paleo Arch* (2017).

<https://doi.org/10.1007/s41982-017-0003-5>

## Contact

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# SCIENCE & SOCIETY // PUBLIC RELATIONS

## INSECT OF THE YEAR 2018: THE SCORPIONFLY



Insect of the Year 2018: The common scorpionfly *Panorpa communis*. © Rainer Willmann



The scorpionfly is commonly encountered in Central Europe – it is particularly numerous in shrubland, along the edge of forests and paths, and also in meadows and fields of stinging nettles. “Nonetheless, this small, four-winged insect is unknown to most people. By choosing it as the ‘Insect of

the Year’ we want to draw attention to the scorpionfly’s special traits and bring them to the public’s attention,” explains Prof. Dr. Thomas Schmitt, director of the Senckenberg German Entomological Institute in Müncheberg and chair of the selection board.

Despite its name, the ‘Insect of the Year 2018’ is not dangerous – and you will look in vain for a stinger. The name of this small Mecopteran fly with dark wing markings is due to the male’s large copulation organ that is carried prominently above the abdomen, reminiscent of a scorpion.

When courting a female, this large abdominal appendix begins to vibrate, and the potential partners draw additional attention to themselves by waving their wings. But that is not all: The male exudes a pheromone and offers the female a high-protein gift from its saliva glands, which the latter begins to eat. “The larger this ‘wedding gift’ and the more frequently it is handed over, the better the male’s chances to be chosen by its intended mate, and the longer the copulation,” adds the entomologist from Müncheberg.

The range of the common scorpionfly spans

all of Central Europe, including southern Scandinavia; in the east, it reaches the northern Balkan peninsula, and in the west, the British Isles. Depending on the climate conditions, the adults hatch from late April to early May from the pupae that winter in the soil.

The “Insect of the Year” has been proclaimed since 1999. The idea was hatched by Prof. Dr. Holger Dathe, the former Head of the Senckenberg German Entomological Institute in Müncheberg. Every year, a board that includes renowned entomologists and representatives of scientific associations and institutions selects an insect from a number of suggestions.

Contact  
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## SCIENCE & SOCIETY // PUBLIC RELATIONS

### GÖRLITZ CHILDREN’S ACADEMY



Elephants in Lusatia? Yes! However, this was quite some time ago – approximately 10,000 years. Back then, the Ice Age steppes were populated by long-haired mammoths, rhinos, wild horses, and aurochs. For the kick-off of the Görlitz Children’s Academy on 12 January 2018, Dr. Olaf Tietz of the Senckenberg Natural History Museum in Görlitz explained how researchers know that these animals formerly lived in our region and what we can tell today about their biology and extinction. The five additional lectures for children between the ages of eight and twelve in the now 27th semester covered the country of Poland, research about reptiles in the jungle, St. Nicholas’s house, butterflies, and comic book heroes. All lectures are held by scientists, thus offering first-hand information. Attendance of the 45-minute lectures is free and only open to children. The lectures are simultaneously translated for Polish children. All participants receive a student ID, and a diploma at the end of the semester.



Participants of the Children’s Academy identify plant seeds. © Senckenberg / Träger

Additional information at:  
[www.hszg.de/kinder](http://www.hszg.de/kinder).

SGN-Ansprechpartner:  
 Dr. Christian Düker  
 Senckenberg Museum für Naturkunde Görlitz

SCIENCE & SOCIETY // PUBLIC RELATIONS

**CULTURE MEETS NATURE: MAN - EARTH - COSMOS - FUTURE**



The project "Culture meets Nature" continues at Senckenberg in 2018 with a four-part concert series by students of the Academy of Music and Performing Arts in Frankfurt am Main (HfMDK) in the Nature Museum Frankfurt.

From contemporary works by Romitelli, Riehm, Eggert, Kagel, Messiaen, Crumb, Cage, and Mark Andre over a performance

by Isabella Roumiantsevo a premier by Richard Millig, young artists of the HfMDK approach the main programmatic pillars of the new Senckenberg Museum: Man – Earth – Cosmos – Future. In their very own and unusual way, the four evenings audibly and visually show what defines us as humans, what the earth looks like, our place in the cosmos, and how we can shape our future. In addition, Senckenberg's expertise made

it possible to examine the four topics from a scientific perspective: Each concert of about one hour was preceded by a guided tour through the museum that matched the topic of the respective music program.

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SCIENCE & SOCIETY // PUBLIC RELATIONS

**SENCKENBERG AWARD 2018: EXTREME HABITATS IN FOCUS**



Bitter cold, enormous glaciers, and bizarre ice formations – the Arctic and Antarctic are among the most fascinating regions on earth. This year's two Senckenberg laureates, Prof. Thorsten Lumbsch, Ph.D., and Arved Fuchs approach these extreme habitats in very different ways.

Lumbsch, laureate in the Nature Research

category, received the award, endowed with 10,000 Euros, for his excellent, internationally visible accomplishments in nature research. The vice president for science and education at the Field Museum in Chicago is considered a global leader in the field of lichen research.

The Senckenberg Award in the Nature Involvement 2018 category, also endowed with 10,000 Euros, is awarded to persons who have demonstrated an outstanding private commitment toward the preservation of nature, nature education, and a sustainable use of natural resources. Expedition leader and author Arved Fuchs counts among these people. The complete crossing of the Antarctic continent in 92 days, the first complete circumnavigation of the North Pole with his sail boat "Dagmar Aaen" or the re-enactment of the Shackleton expedition in Antarctica are among his most successful ventures. With the Ice Climate Education Camp in the Arctic he developed a format that brings climate change to young

people in an understandable, hands-on fashion.

During a formal dinner, the 200 guests of the 10th Senckenberg Night from the political and economic sectors, society, and science were treated to a "diverse menu" by the chef of the essBar, Moritz Müssig. Under the direction of Jens Daryousch Ravari, the Senckenberg Night comprised a variety of artistic program items, including a performance by pianist Nuron Mukumi, songs by the "Senckenberg Kids," and a dance performance by the Dresden Frankfurt Dance Company. Speeches by Volker Bouffier, the event's patron and minister president of the State of Hesse, and by Peter Feldmann, Lord Mayor of the City of Frankfurt, complemented the event.

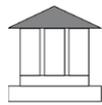


Dr. h.c. Beate Heraeus, Senckenberg president and initiator of the Senckenberg Night, with laureates Prof. Thorsten Lumbsch, Ph.D., and Arved Fuchs as well as Senckenberg Director General Prof. Dr. Dr. h.c. Volker Mosbrugger at the Senckenberg Nature Museum Frankfurt (left to right). Photo: Senckenberg

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SCIENCE & SOCIETY // PUBLIC RELATIONS

**'CITIES BRAVE THE WILDERNESS' RECOGNIZED AS AN OFFICIAL PROJECT OF THE "UN DECADE BIOLOGICAL DIVERSITY"**



Generally, wilderness is seen as a disheveled chaos that is best avoided. Now the federal project "Cities Brave the Wilderness" – in which the City of Frankfurt participated along with the cities of Hannover and Dessau-Roßlau – wants to show that wilderness can also be beautiful, suspenseful, exciting, and full of surprises.

The joint project, under Senckenberg's scientific supervision, was now recognized as a UN Decade Project. As part of the "Biological Diversity" competition, actions that notably promote the preservation of and education about biological diversity are awarded a prize.

In Germany, the UN Decade started in 2011 and will be implemented until 2020 on behalf of and in close cooperation with the Federal Ministry for the Environment (BMUB)

and the Federal Nature Conservation Office (BfN) by the UN Decade's branch office. Each week, a project is recognized that shows particular commitment toward the preservation, use or education regarding biological diversity. Additional information about the UN Decade Biological Diversity can be found at [www.undekade-biologischesvielfalt.de](http://www.undekade-biologischesvielfalt.de).

The "Cities Brave the Wilderness" project is accompanied by the Federal Ministry for the Environment and receives financial support from the Federal Nature Conservation Office (BfN) for five years (from 2016 until 2021).

Additional information at [www.staedte-wagen-wildnis.de](http://www.staedte-wagen-wildnis.de)

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Male sand lizard, photographed in "wild Frankfurt."  
© Andreas Malten

# SCIENCE & SOCIETY // MUSEUMS

## SPECIAL EXHIBITION "MONSTERS & MYTHS" – SEA MONSTERS, UNICORNS AND COMPANY



For ten months, visitors will have an opportunity to marvel at life-sized reconstructions of sea monsters, Bigfoot, Yeti and company in the special exhibition "Monsters & Myths" at the Japanese Palais in Dresden. Since ancient times, countless stories about the most fantastic creatures have abounded around the globe. Wild mountainscapes, extensive, dense forests and not least the mysterious depths of the oceans inspire human imagination until today. Scary sea monsters, the legendary Nessie, wild apes, and fabled unicorns – do they really exist, or are they merely a myth? The exhibition follows the tracks of these mythical creatures and reveals the scientific facts behind them.



Megamouth shark in the special exhibition "Monsters & Myths." © Senckenberg

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### SCIENCE & SOCIETY // MUSEUMS

## AWARD-WINNING TRAVELING EXHIBITION



The Senckenberg traveling exhibition 'Planet 3.0' presents the earth as a living system with an eventful past. It vividly illustrates the development of climate and life during the past 650 million years. To this end, researchers and designers developed seven images that serve as walk-in dioramas and show what the earth might have looked like in the past. A multi-media globe projection opens the second part of the exhibition. Here, science can be experienced first-hand: At seven research tables, leading institutes present their current research projects – an authentic look over the shoulder

with hands-on experience. Visitors will leave the exhibition with a deeper knowledge of the treasure – the earth – they live on. The exhibition was recognized as a "winner" with the German Design Award 2018. The jury's reasoning: "The carefully designed, highly detailed traveling exhibition is presented on a formally and didactically high level and makes the topic emotionally accessible to young and old visitors alike – an educational as well as exciting tour-de-force."

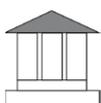


Award-winning traveling exhibition: Planet 3.0. © Senckenberg

Contact  
 Dr. Thorolf Müller  
 Stab Zentrale Museumsentwicklung

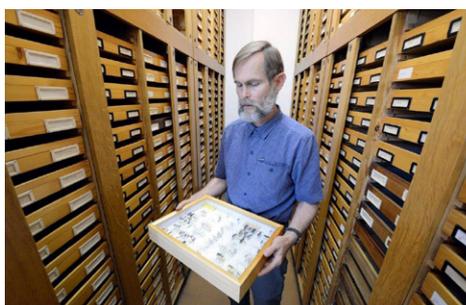
### SCIENCE & SOCIETY // MUSEUMS

## COLLECTION, RESEARCH, DISSEMINATION – ACTION PLAN OF THE LEIBNIZ RESEARCH MUSEUMS



The eight research museums of the Leibniz Association aim to further strengthen their special role as sites of research, education and knowledge transfer with a joint action plan. To this end, the plan envisions the focal points of science communication, dissemination research and standards as well as international networking. On the occasion of the European Year of Cultural Heritage 2018, the Leibniz research museums put on various joint activities. Their emphasis is placed on making known the importance of conservation and restoration research for the preservation of the

cultural heritage. Topical weeks and practical seminars are planned to offer the public



a look behind the scenes of the museum's workshops.

The Senckenberg topical week in late April/early May had the motto "Collections – from Gathering to Analysis." Seven institutions of the Senckenberg Gesellschaft für Naturforschung offered guided tours behind the scenes, excursions, laboratory visits, and an Open House Day.

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SCIENCE & SOCIETY // MUSEUMS

**A LOOK INTO THE FUTURE: THE BIO COMPASS PROJECT**



The toothbrush in the morning, the drive to work, a coffee to go – every day we use products that are based on fossil raw materials, often without even noticing it. But global climate change, loss of biodiversity, and the securing of the food supply for an ever-growing world population pose large challenges for humanity in the near future. Creative ideas and promising innovations are needed as the basis for a sustainable economy that protects the environment and thus the basis of human life. Bio-economy offers potential approaches to this problem. It counts on plants, animals, microorganisms, and even waste products as a basis for so-called bio-based products. The basic materials are renewable, conserve resources, and frequently replace fossil-based raw materials. The vision is a knowledge-based cyclic economy that uses the highest possible amount of all materials and produces a minimum of waste.

However, the use of biomass and the intensification of agriculture in many areas also raise questions about risks and limitations. Many aspects of bio-economy lead to controversy and target conflicts. A lively discussion is already taking place in scientific circles, and the BioCompass project aims at picking up this discussion to bring it to the wider public – for the transition to a bio-based economy with all its innovations requires a high level of acceptance and a willingness for change in the population and depends on the public’s ideas and creativi-

ty. The project’s goal is to promote the opinion-making process in the field of bio-economy and to facilitate an exchange between research, economy, and society.

A team of cooperation partners from a wide variety of fields under the guidance of the FraunhoferInstitute for System and Innovation research (ISI) in Karlsruhe is working to realize these goals. Beside the Senckenberg



Instead of plastic: Sustainable construction and modelling – children reconstruct dinosaurs using renewable resource-based components during a birthday action in the Senckenberg Nature Museum. Photo: Norbert Miguletz

Gesellschaft für Naturforschung (SGN), other participants include the FraunhoferInstitute for Graphic Data Processing (IGD) and for Chemical Technology (ICT) as well as the Institute for Social-economic Research (ISOE). Together with participating persons from a wide variety of areas they pursue the question which topics and focal points of a bio-based economy should be emphasized in the future. These future images are then presented in the Senckenberg Nature Museum: A special interactive exhibition area –

the Evolving Lab – highlights current results from the project. Here, the visitors will not only receive information but can also contribute their own opinions, experiences and expertise, thus aiding in the continuous further development of these future images.

Workshops held by various cooperation partners further involve a target group that will be particularly affected by bio-based innovations: High school students from the upper grades independently develop educational content and dissemination formats. In cooperation with experts, they record videos, develop the basis for digital applications, or design museum exhibits. Controversial topics, conflicts and hopes can thus be made apparent, and the formation of opinions is promoted.

Additional information at:  
[www.senckenberg.de/biokompass](http://www.senckenberg.de/biokompass)

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SCIENCE & SOCIETY // MUSEUMS

**VIRTUAL REALITY: A DIVE INTO THE JURASSIC SEA AND AN ENCOUNTER WITH SPRINGTAILS**



Germany possesses a wealth of fossilized marine dinosaurs that populated the shallow tropical seas of the Jurassic between 200 and 145 million years ago. The Senckenberg Nature Museum in Frankfurt also contains numerous outstanding specimens from this period: ichthyosaurs with preserved skin shadow, marine crocodiles, and plesiosaurs. Thanks to 150 years of research, much is known about these long-extinct animals – what they ate, how they swam through the water, and much more. Following the popular VR journey into the age of dinosaurs, in which the skeleton of Diplodocus comes to live in a Jurassic jungle, the museum’s atrium is now being converted into a tropical Jurassic sea.

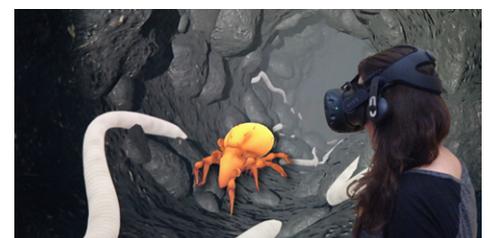
The “Jurassic Sea” VR installation, along with the VR journey into the age of dinosaurs introduced in 2016, can be experienced every day from 11 am until 4 pm on the first floor of the Senckenberg Nature Muse-

um. The project is financed with means from the Leibniz Research Museums’ action plan and from donations by members of the Senckenberg Gesellschaft für Naturforschung.

But dinosaurs are not all that is virtually brought back to life at Senckenberg – in the museums in Frankfurt and Görlitz, the virtual reality application “Soil” carried visitors off into the hidden world below our feet. Once you don the VR goggles, you feel reduced to the size of an isopod and are thus able to explore the soil’s fauna. A hand-held controller serves as a flashlight on the tour and makes it possible to virtually move through the dark tunnels in the soil and encounter springtails, moss mites, Enchytraeid worms, centipedes and other soil denizens. The Senckenberg Natural History Museum in Görlitz, which specializes in soil zoology, developed this virtual reality animation in the context of the federal project

“museum4punkt0 – Digital Strategies for the Museum of the Future.”

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Discovering the fauna in the soil with VR goggles. Copyright: Uwe Vaartjes

# SCIENCE & SOCIETY // CITIZEN ENGAGEMENT

## SENCKENBERG IN SOCIETY 2018: LIFE IN THE CORAL REEF – EVERYTHING IS SO COLORFUL HERE?



Once a year, the Senckenberg member support invites the Permanent Members and Senckenberg Friends to an evening filled with science, good food, and pleasant conversation. For the fourth time, the Senckenberg in Society event series gave this group of members the opportunity to get to know our scientists and their areas of expertise up close and personal, to initiate contacts, and to explore possibilities for future involvement.

On 8 June, the evening's motto was "Life in the Coral Reef – Everything is so Colorful Here?" In her opening address, board member Prof. Dr. Katrin Böhning-Gaese stressed the importance of the Senckenberg members' involvement for our society and addressed the political and strategic significance of marine research. The up-and-coming scientist Torben Riehl from the Section for Marine Zoology and political scientist Julia Dupont of the Goethe University in Frankfurt shed light on the impor-

tance of marine research for our society. Marine biologist Moritz Sonnewald took the audience on an excursion to the Red Sea in his lecture "Fascinating Coral Reefs," and the zoological taxidermist Hildegard Enting offered a look into the preparation work at Senckenberg by describing how a reef finds its way from the ocean into the museum. In addition, the event offered an opportunity to say thank-you to the Permanent Members and Senckenberg Friends for the realization of the "Jurassic Sea" virtual reality application, which was made possible in part by donations from 'Senckenberg in Society 2017.' This year's fund-raising object: A model of the sea slug *Costasiella kuroshimae*, which bears a striking visual resemblance to the animated movie clay figure "Shaun the Sheep" that is very popular with children.



Fundraising object: Model of the sea slug *Costasiella kuroshimae*. Photo: Fotolia /Prilfish

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Stab Kommunikation

### SCIENCE & SOCIETY // CITIZEN ENGAGEMENT

## PROJECT "BLOOMING MEADOWS FOR SAXONY'S BUTTERFLIES" RECEIVES AN AWARD



Everyone can make a contribution toward helping butterflies! That is the message sent by the "Blooming Meadows for Saxony's Butterflies" project. The initiative, led by the Saxonian State Foundation for Nature and the Environment, Nature Protection Funds, shows that even simple measures can increase species diversity in meadows and public greenspaces. Due to its exemplary commitment to biodiversity, the butterfly meadows were recognized as a UN Decade Project.

It is the project's main goal to achieve that the meadows in cities and villages are mowed less frequently, and that only 70-90 % of the meadows are cut. Contrary to clearcutting, this ensures that a few plants are left standing that host the eggs, larvae or pupae of butterflies and other insects. These "pupae repositories" serve as a starting point for the resettlement of mowed meadows. One of the project's special features is its interactive approach. The website ([schmettlingswiesen.de](http://schmettlingswiesen.de)) offers tips for meadow areas well as interesting information about butterflies and their host plants. People who would like to maintain their own butterfly meadow can order or butterfly meadow sign. A free app aids in identifying butterfly species and allows the reporting of observations. The "meadow stewards" can share their experiences via a blog.

the Environment, Nature Protection Funds, the Senckenberg Museum for Zoology in Dresden, The German Nature Conservation Federation (NABU), the State Association Saxony e.V., the German Association for Landscape Maintenance (DVL), and the Landscape Maintenance Association Torgau-Oschatz e. V.

Contact  
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Senckenberg Naturhistorische Sammlungen Dresden



A growing butterfly meadow.

Photo: [www.schmettlingswiesen.de](http://www.schmettlingswiesen.de)

## SCIENCE & SOCIETY // CONSULTATION

### SCIENTISTS AGREE:

#### THE TIME FOR ACTION IS NOW – HEARING AT THE STATE PARLIAMENT OF SAXONY ABOUT THE INSECT DIE-BACK



Hoverflies are important pollinators for many plant species. Pictured a group of marmalade hoverflies on a mullein. Photo: ReinartFeldmann / UFZ

going a drastic reduction over large areas – with a significant impact on nature’s food chains. Most of the experts were in agreement that this development calls for urgent action. A large part of the responsibility lies squarely with the current land use practices – from the agricultural landscape to private gardens, as well as the framework conditions set by agricultural policies. These include the loss of small-scale structures in the landscape, leading to the increasing isolation of habitats; a dominance of only a few cultivated varieties that mostly impede the survival of traditional plant and animal species in agricultural areas; and the use of herbicides in agriculture, forestry and on private land, which as a rule do not specifically target the pest organisms but also harm other creatures in the process.



On the basis of two applications by the state parliamentary groups “Bündnis 90/Die Grünen” (Green Party Federation 90) and “Die Linke” (the Left Party) in the Saxonian State Parliament, the Parliamentary Committee for the Environment and Agriculture conducted a public hearing of experts on 2 March in Dresden. The hearing was attended by a total of eight experts, including Dr. Matthias Nuss of the Senckenberg Museum for Zoology in Dresden.

The entire hearing was characterized by a wide variety of topics and the high-quality content of the contributions. The subsequent round of questions proved constructive and comprehensive from the scientists’ perspective. All experts agreed that Germany is experiencing a drastic loss of insects. Scientific analyses reach the unanimous conclusion that many species are becoming rare in the short and long run, are going extinct on a regional or even national level, and that the overall insect biomass is under-

#### Contact

Dr. Matthias Nuss

Senckenberg Naturhistorische Sammlungen Dresden

## SCIENCE & SOCIETY // APPLICATION

### A NEW SPIN-OFF: BIOME-ID – ANALYSIS OF SPECIES DIVERSITY FOR PRACTICAL APPLICATION



The company biome-id is a spin-off of the German Center for Marine Biodiversity Research (DZMB) at the “Senckenberg by the Sea” research institute in Wilhelmshaven; it was founded in 2017 as a start-up by a team of scientists. The two founders, Dr. Andrea Barco and Dr. Thomas Knebelsberger, have years of experience in the field of molecular biodiversity research. The company’s goal is to make modern and innovative procedures for analyzing species diversity available for common application, in order to ensure and improve the long-term use of natural environmental resources. On the basis of DNA analyses, biome-

id guarantees the fast and reliable identification of organisms. Depending on the customer’s wishes, the team will analyze individual organisms or parts thereof, mixed samples, or DNA from water and soil samples. Alternatively, it also offers a fast and cost-effective method of species identification based on the analysis of proteins.

The service of biome-id is catered toward environmental agencies and environmental consulting firms, research institutions, authorities, and industries that wish to apply new, ground-breaking technologies in the context of bio-assessments.

For its development of the protein-based identification of multi-cell organisms, in

2017 the team, in cooperation with the Start-up and Innovation Center (GLZ) of the University of Oldenburg, was awarded an EXIST Start-up Grant by the Federal Ministry for Economy and Energy.

Additional information and contact at:  
<https://www.biome-id.com/>

# RESEARCH INFRASTRUCTURE

## HESSIAN RESEARCHERS AIM TO DECIPHER THE CODE OF ALL LIFE – GREEN LIGHT FOR THE LOEWE RESEARCH CENTER



To date, 95 percent of the genome of animals, plants, and fungi is still unknown. The new research center for Translational Biodiversity Genomics (TBG) aims to change this in the context of the Hessian LOEWE initiative and to illuminate the murky secrets of the organisms' genome by means of a globally unique sequencing offensive. The

information gained in the process will benefit both medical science and species protection.

The analyses will also include exotic creatures such as gastrotrichs ("hairybacks"), arrow worms and oomycetes, isopods, snails, and lichens, which have been mainly neglected in the genome research to date. All sequenced genomes will be included in a

currently unique digital compilation, the "Senckenberg Biodiversity Genome Collection." This will be primarily used by the international research community, since this genome library of life will be accessible via a web portal. The center further aims to set new standards in regard to the practical application of results from the basic research.

In the center, researchers from the Senckenberg Gesellschaft für Naturforschung, the Goethe University in Frankfurt, the Justus Liebig University in Gießen, and the Fraunhofer Institute for Molecular Biology and Applied Ecology IME work together. In March, State Minister Boris Rhein handed over the sponsoring certificate to the new center's board of directors, signifying the official kick-off.

For the past ten years, the Hessian "State Offensive for the Development of Scientific-economic Excellence" (LOEWE for short), has supported excellent research in the State of Hesse with more than 700 million Euros.



Handing over of the sponsoring certificate to the LOEWE Center "TBG-Translational Biodiversity." From left to right: Minister Boris Rhein, Prof. Dr. Axel Janke (Scientific coordinator LOEWE-TBG, Senckenberg Gesellschaft für Naturforschung & Goethe University) Photo: Senckenberg

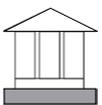
**Contact**

Prof. Dr. Axel Janke

LOEWE Forschungszentrum Translationale Biodiversitätsgenomik & Senckenberg Biodiversität und Klima Forschungszentrum

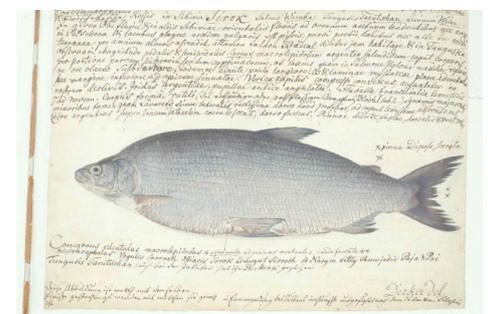
RESEARCH INFRASTRUCTURE

## SENCKENBERG'S LEGACY IN THE INTERNET



The archival heritage of Johann Christian Senckenberg comprises 373,390 individual pages and more than 56 shelf meters from the time between 1730 and 1950. For historical reasons, the estate of the physician, founder, and scholar from Frankfurt is stored in various cultural heritage institutions in Frankfurt. The archived materials of the Institute for City History, the J. C. Senckenberg University Library, and the Senckenberg Gesellschaft für Naturforschung are now brought together in an online archive. "Important cross-connections exist between the various documents that are difficult or even impossible to recognize in the analog world with its different locations," explains Prof. Dr. h. c. Volker Mosbrugger, director general of the Senckenberg Gesellschaft für Naturforschung, and he continues, "With the intended digitization,

we are able for the first time to offer the public as well as the scientific community free and complete access to this information." The inventory comprises the estate of Johann Christian Senckenberg – including 53 quarto volumes with 700 journal pages each from the years 1723 to 1772, the document inventory of the Dr. Senckenberg Foundation, the extensive archive of the Senckenberg Gesellschaft für Naturforschung (SGN), and several personal estates. All documents are directly linked with Senckenberg as a person, the foundation's history, and the SGN. The documents can be used for the exemplary illustration of the rapid rise of modern science culture from the 19th century until the mid-1900s: the development from a universal to a systemic science, the history of "Citizen Science" and the processing of nature research institutions during the Nazi period. The latter was only



Drawing of a fish by naturalist Wilhelm Gottlieb Tilesius von Tilenau (1769-1857) from the Senckenberg archive © Senckenberg

recently implemented by sociologist and historian Dr. Andreas Hansert in his book "The Senckenberg Research Museum during National Socialism. Facts and Fiction" on the basis of the archives," adds Mosbrugger. >>

The digitization, which is planned for the coming three years and supported by the DFG, is both a challenge and an opportunity for the involved institutions. The documents are characterized by a particular diversity of media, types of materials and formats, and as scientific relevant information carriers they are subject to especially high quality demands in regard to the digitization results.

By the end of the project, the major part of

the Senckenberg inventory will be digitized, virtually combined, and offered for general access at no cost in a joint presentation platform provided by the J. C. Senckenberg University Library as well as in the Archive Portal-D.

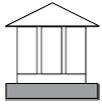
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#### RESEARCH INFRASTRUCTURE

### GENOMICS AGAINST SPECIES DIE-BACK



For the past 300 years, "taxonomy" has tried to describe the confusing diversity of species that populate the earth and put them into some kind of related order – a systematic system. "In this, the examination of the organisms' genome is gaining increasing importance," explains Dr. Christian Printzen of the Senckenberg Research Institute in Frankfurt, and he continues, "The DNA helps us taxonomists and systematic biologists to differentiate between species and to determine their phylogenetic trees. This allows us to quickly recognize even visually similar species. The acquired data are urgently needed, especially in this time of massive global species die-backs, to enable us to take appropriate conservation measures."

The DFG is now combining means to support research projects that connect taxonomy and genomics in a new emphasis program called "Taxon-OMICS." It is the program's goal to find new methods and approaches to making taxonomy faster and more cost-effective. Four working groups at Senckenberg receive almost one million Euros from this program toward the study of the origin and delimitation of species from a wide variety of groups and habitats.



One of the "Taxon-OMICS" research objects: A copepod from the North Sea. Photo: Senckenberg

Additional information at:

<http://www.taxon-omics.de>

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# PERSONAL PARTICULARS

## JEWELRY IN THE PALEOLITHIC - SIBYLLE WOLF RECEIVES THE KURTBITTELAWARD FOR HER DOCTORAL THESIS



Senckenberg scientist Sibylle Wolf is handed the Kurt Bittel Award by Heidenheim's Lord Mayor, Bernhard Ilg. Photo: Wolfgang Heinecker/City of Heidenheim

search in an exemplary manner that is easily understandable for laypersons as well. Among others, the researcher examined pieces of ivory jewelry that were found in caves in the Swabian Alb mountains. In the past decades, excavations unearthed numerous pieces of jewelry, including a striking number of pearls pierced with double holes. According to Wolf, this type of jewelry is exclusively found in this region, spanning a period of at least 6000 years. This indicates that the pearls were produced and worn as a symbol of a shared identity by the hunter-gatherer clans in the Swabian Alb. The production was labor-intensive and required a high amount of artistry as well as the use of various tool. The KurtBittelAward for Southern German archeology is named for the Heidenheim archeologist Professor Dr. Dr. h.c. Dr. h.c. Kurt Bittel. In his honor, the city of Heidenheim has awarded a prize for exceptional scientific work in the field of Southern German archeology every two years since 1987. Each award winner receives the sum of 5,500 Euros.

In mid-November 2017, the archeologist and scientific coordinator of the Senckenberg Center for Human Evolution and Palaeoenvironment (HEP) at the University of Tübingen, Dr. Sibylle Wolf, received the Kurt Bittel Award for her doctoral thesis

about the processing of mammoth ivory and ivory jewelry in the Upper Paleolithic. The jury found that Wolf's comprehensive work about ivory from the Aurignacian (Upper Paleolithic) closes a research gap. Moreover, she presents her archeological re-

SGN-Ansprechpartnerin:  
Sibylle Wolf  
Senckenberg Center for Human Evolution and Palaeoenvironment

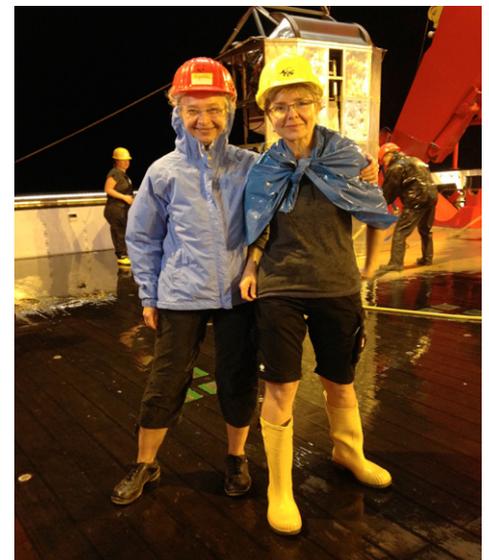
### PERSONAL PARTICULARS

#### ALUMNI PORTRAIT

Marina Malyutina works at the „End of the World“ - she is a scientist at the National Scientific Center of Marine Biology in Vladivostok, Russia, and is an expert on the taxonomy of deep-sea isopods. The crustaceans provide many important findings about this largely unexplored habitat. Since 2010 Marina has cooperated with Prof. Dr. Angelika Brandt (Senckenberg Research Institute and Natural History Museum Frankfurt) and participated in several Russian-German deep-sea expeditions that have brought forth invaluable biological materials, which is now largely stored in the collections of the Department of Marine Zoology at the Senckenberg. During a stay in April 2018, sponsored by the research alumni network Senckenberg, Marina had the opportunity to work on materials from the last Kuram-Bio II expedition taken from a depth of 9580 meters in the KurilKamchatka-Trench. Her

conclusion: „I greatly appreciate the Senckenberg collections and my stay was very pleasant and productive, not least because of the excellent organization on site and the renovated premises in the Arthur-von-Weinberg-House“. The long-term collaboration will continue in the future, because there is still much to discover in the deep sea!

Contact  
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Stab Wissenschaftskoordination



Marina Malyutina (right) and Angelika Brandt at work on the FS „Sun“