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Ozone removes mating barriers between fly species

Elevated ozone levels increase the likelihood that hybrids will occur between different species of the genus *Drosophila*, most of which are unable to reproduce ... p. 4

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Andrés Brunetti studies the interactions between newts and their bacterial symbionts, as well as the possible involvement of these bacteria in the biosynthesis of the neurotoxin ... p. 5

Combating species decline and insect extinction

We want to promote biodiversity on the Beutenberg Campus by implementing a biodiversity-friendly approach to maintaining green spaces ... p. 6

MAX PLANCK GESELLSCHAFT

EDITORIAL

We are committed to diversity and openness to the world!

MPI-CE staff at the Jena Company Run 2024. A diverse community is a key ingredient of strong team performance, not only in sports, but also in science. Photo: Karin Groten

We used Diversity Day 2024 on 28 May to highlight the benefits of a diverse institute community and our activities in this context. We also presented new books and games from our diversity bookshelf. Photo: Anja Kirschner

Our institute has embarked on a journey towards greater inclusion and empowerment of all staff. Funding from the Max Planck Diversity Excellence Fund, obtained in 2023, is underpinning our effort. We have made concrete changes, such as converting some toilets to unisex and installing dispensers for hygiene products, to ensure that all people, regardless of their gender identity, feel accepted and welcome.

Our diversity initiative is reflected in our monthly diversity newsletter, which serves as a platform for cultural exchange. From highlighting regional celebrations to insights into awareness days or different cultural traditions, each issue is designed to promote a sense of unity in diversity and encourage employees to participate in local community events. In this way, we hope to promote the region's cultural and scenic highlights. We are especially proud of our international and intercultural Advent calendar, showcasing global traditions and festivals celebrated in December in other regions and cultures.

"It's pretty clear to me that talent is equally distributed, it is opportunity that is not. If research institutions want to attract and retain the best talent, they need to become more diverse. Diversity is simply good for science".

Yuko Ulrich, Lise Meitner Group Leader

We organize joint excursions and visits to local museums. At the heart of our diversity project is a series of workshops on diversity, equality and inclusion (DEI), including awareness raising and prejudice reduction. Through regular DEI meetings and other dialogue forums, we aim to create a working environment where every voice is heard and valued, and where all employees feel seen.

"Germany is a great science location that can compete with the best locations in the US. This is mainly due to the fact that we can attract the best talent from all over the world. This is what makes science and technology in Germany so competitive".

Sarah O'Connor, Director, Department of Natural Product Biosynthesis

People from 45 nations work at our Institute. Whether in administration, technical service, IT, scientific support or research, everyone contributes to ensuring that science is conducted at the highest level. The diversity of our staff enriches our day-to-day work at the Institute and is essential for world-class research.

Members of the institute at the demonstration under the motto "Defending democracy" on Jena's church square in January 2024.

"This is the best possible environment for my scientific work: an open-minded, collaborative and diverse community of brilliant people from all over the world. It would be a pity if these fantastic conditions for carrying our research were to change, because I believe that both foreigners and Germans benefit from the exchange of ideas, points of view, and knowledge".

Ana Baños, Doctoral Researcher

"I have worked in different companies with colleagues from all over the world. Precisely because I have never had to leave my home country, different experiences and approaches are an invaluable asset for me. Jena and Thuringia have come a long way and I want to see this success story continue".

Thomas Melzer, Head of Building Services

Worryingly, in Thuringia, there is an emerging shift to the right and a high level of support for right-wing extremist parties. Many of our institute members took part in demonstrations for democracy. At the beginning of 2024, an alliance was formed, the "Weltoffenes Thüringen" (a Thuringia that is open to the world), which is also supported by the three Max Planck institutes in Jena. Together with companies, universities and civil society organizations, we are setting an example of democracy and openness to the world, the basic prerequisites for our research. Our international scientists and all employees regardless of where they are from are indispensable to us.

That any employee might not feel welcome in Thuringia undermines our institute, our research and the future of our society as a whole. We are therefore actively committed to ensuring that this will not happen.

https://thueringen-weltoffen.de/

The Max Planck Institute also visibly supports the "Weltoffenes Thüringen" initiative.
Photos: Angela Overmeyer

RESEARCH HIGHLIGHT

Ozone removes mating barriers between fly species

Dr. Markus Knaden is concerned that air pollution severely disrupts the chemical communication of insects and contributes to the global decline of insect populations.

Below: A female **Drosophila simulans** *is being courted by a male of the species* **Drosophila mauritiana.**
Photos: Anna Schroll

Insect pheromones are odor molecules used for chemical communication within a species, especially during mating. An earlier study by researchers in the Department of Evolutionary Neuroethology led by Nanji Jiang, Bill Hansson and Markus Knaden showed that elevated ozone levels disrupt chemical communication in flies. Ozone destroys carbon-carbon double bonds in pheromones, making it impossible for male flies to distinguish between females and males.

The researchers have now investigated whether ozone also affects mating boundaries between different species and found that elevated ozone levels can lead to increased hybridization between closely related species of the genus *Drosophila*. In their experiments, the scientists exposed four species of *Drosophila* to ozone levels commonly found in our cities on summer days. They found that females often chose males of other species, leading to an increased number of hybrids.

Although flies rely on acoustic and visual signals as well as chemical ones to choose mates, ozone made it impossible for females to distinguish between conspecifics and foreign males. Male hybrids are usually sterile, while female hybrids are fertile; surprisingly, some male flies prefer to mate with hybrid females. In principle, this consequence of ozone in the atmosphere could lead to the emergence of hybrid species in the long term.

Moreover, the researchers fear that ozone could disrupt not only mate choice but also other forms of chemical communication in insects, such as the use of aggregation or alarm pheromones. Social insects such as ants, which rely on pheromone trails to navigate, could also be affected. In addition, other pollutants such as nitrogen oxides could amplify the effect of ozone.

Based on these findings, the scientists are calling for a reassessment of air pollution limits, as even small amounts of polluntants significantly impact insects' chemical communication. Given the dramatic decline in insect populations worldwide, all possible factors contributing to this decline need to be further investigated and addressed.

Original Publication:
Jiang, N.-J., Dong, X., Veit, D., Hansson, B. S., Knaden, M. (2024).Elevated ozone compromises mating boundaries in insects. **Nature Communications**, 15: 2872

Dr. Nanji Jiang uses flies that have previously been exposed to ozone for experiments.
Photo: Anna Schroll

Unraveling the mystery of TTX in newts

Humboldt Fellow Dr Andrés Eduardo Brunetti has been fascinated by amphibians for more than 15 years, and more recently by their symbiotic interactions and how these symbioses contribute to the chemical repertoire of amphibian skin secretions. The Max Planck Institute for Chemical Ecology, with Prof. Dr. Martin Kaltenpoth's expertise in the field of symbiosis, is the perfect host for this research. Funding from the Humboldt Foundation allows him to study these exciting interactions in more detail. Here he presents his project:

"The neurotoxin tetrodotoxin (TTX) has always had something mysterious about it for me. The mystery of TTX also lies in its history. Although its toxic effect has been known to Chinese and Egyptian cultures for over 2500 years and its structure was elucidated in the 1960s, it remains a puzzle where exactly the poison comes from.

To complicate matters, TTX is found in different environments - marine, freshwater and terrestrial - and in different animals, including fish, mollusks, flatworms and amphibians. This unusual distribution suggests a bacterial source, which has been confirmed by the identification of several TTX-producing bacteria isolated from animals. However, this production is often unstable and disappears after isolation.

There is evidence that TTX is produced in the body of newts. That there are four species of newts in Germany offers an excellent opportunity to unravel some of the secrets. In our project, we aim to investigate the TTX content in newts from different German populations, understand the ecological factors that influence this content, determine whether bacterial symbionts on the skin of newts are the source of TTX and elucidate the biosynthetic pathway.

Our research involves field work in Thuringia, Saxony and Saxony-Anhalt. We catch newts with nets, take skin swabs for chemical and microbiological tests, measure them and return them to the ponds. We also take environmental samples and measure water parameters. In the laboratory, we extract TTX from the swabs and quantify its concentration using liquid chromatography and mass spectrometry. We also extract DNA and sequence specific DNA segments to characterize the bacterial and fungal communities. Previous projects have shown that bacterial symbionts in male and female frogs produce different volatile substances that may act as sex pheromones. Host metabolites can also regulate bacterial communities, suggesting an underlying chemical interaction that benefits both host and bacteria.

I have been pleasantly surprised by the interest and curiosity of the public. People often ask about our research and express concerns about newt populations suffering from drought or about exotic fish. Their attention and observations can make an important contribution to our work, and many answers can be found close to home, for example in a neighbor's pond. An understanding of the richness of the environment and its interrelationships, some of which are hidden or microscopic, benefits the observer and the observed."
Andrés Eduardo Brunetti

Dr Andrés Brunetti, Department of Insect Symbiosis, studies newts in a pond near Jena, Germany. With a Georg Forster Research Fellowship from the Alexander von Humboldt Foundation, the Argentinean scientist is studying the symbiosis between newts and the bacterial symbionts that are present on the amphibian's skin. Foto: Danny Kessler

Below: The common newt **Lissotriton vulgaris** *is the smallest and most widespread of the four species of newt found in Germany; the others include the great crested newt, the alpine newt and the palmate newt. Newts protect themselves from predators with a poisonous skin secretion. How the toxin is produced is still unclear.* Photo: Benjamin Weiss

BIODIVERSITY CONCEPT

Combating species decline and insect extinction

Meadow on the campus between the Max Planck Institutes for Biogeochemistry and Chemical Ecology. A biodiversity-friendly maintenance concept is intended to ensure that the diversity of plant and insect species on the Beutenberg Campus increases.
Photo: Angela Overmeyer

Below: Marbled white butterfly, eastern burnet and bumblebee on a knapweed. Photo: Angela Overmeyer

On the right: The institute regularly monitors insect species on campus with a team of biologists and records their diversity.
Photo: Karin Groten

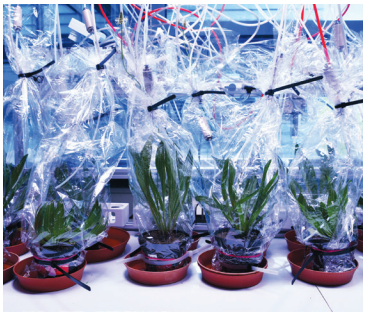
Every year, new studies show the extent to which biodiversity is declining across the world. Many animal and plant species are disappearing completely or their populations are declining dramatically. Human activity is a major contributor to this. At the same time, through thousands of years of agricultural use, humans have created a richly structured landscape in central Europe that has provided and continues to provide a habitat for many species. Grasslands are one of the most valuable habitats created by humans. More than half of all plant species in Germany can be found in meadows or pastures. But not all grasslands are equally valuable. For example, a meadow that has been scythed and hayed for centuries is rich in structure and can support up to 50-80 insect species per 25 square meters, whereas a nutrient-rich, intensively grazed or frequently mown meadow can only support an average of 10-20 species per square meter. It is not enough to provide food for the adult insects of some groups – buzzing bees and colourful butterflies – for a few weeks in summer with standardized flower mixtures; the eggs, caterpillars or nymphs and pupae of the insects need a habitat all year round. Such a habitat was provided by traditional haymaking, but this practice is dying out in Germany. However, we can still do something about the threat to our insects on a small scale.

Our institute is part of the Beutenberg Campus, an area with many open spaces of all sizes between buildings. In the past, these areas were mowed and fertilized more than eight times per year. Our Institute's Sustainability Commission, founded in 2022, is reexamining this practice. Under the leadership of our greenhouse manager, Dr Danny Kessler, and in consultation with the other institutes on campus, in particular the Universität Jena Service-Gesellschaft, which looks after campus grounds, and with the support of the city's nature conservation authority, we have developed a mowing concept that aims to promote both insect and plant diversity.

"Less is more" is the motto. The areas are now mowed once or twice a year at the most. Mowing is staggered, i.e., only parts of the plots are mowed at different times, to provide refuge for insects and to allow recolonization and development to occur. The mown material is not removed until two to three days after cutting, so that all the seeds and insects are not removed from the area at the same time. Leaving perennial grass is particularly important for the overwintering of many insect species. This mowing technique has also been adapted to increase the chances of survival for insects. At the same time, neophytes such as the Turkish warty-cabbage *Bunias orientalis* are controlled to prevent their mass spread.

2024 is the first year that this concept has been implemented and we, as an institute, will monitor it and record the biodiversity once a year.
Karin Groten

New habitats influence the plant's defenses



Odor collection on ribwort plantain plants after caterpillar feeding. 19 different plantain populations, whose seeds were collected from different locations around the world, were grown in a greenhouse, and their growth and accumulation of defense compounds were analyzed.
Photo: Sybille Unsicker

An international team of researchers led by Sybille Unsicker and her group at the Department of Biochemistry has investigated whether the chemical defenses of plants change when they colonize new geographical regions.

Greenhouse experiments with populations of ribwort plantain (*Plangato lanceolata*) from different countries and continents have shown that introduced ribwort plantain populations exhibited higher chemical defenses when climatic factors of their habitat were taken into account, while their growth was not affected. Populations of ribwort plantain outside their original range are just as well defended, and in some cases even-better chemically protected than native populations.

The study provides initial insights into the global success of ribwort plantain, but only partially clarifies the role of climatic conditions. Future experiments will investigate how different ribwort plantain populations respond to a combination of stressors. This will take into account a more realistic set of environmental conditions, such as those found in a changing climate.

The results challenge current theories and show how difficult it is to formulate universal assumptions in ecology..

Original Publication: Medina-van Berkum, P. et al. (2024). Plant geographic distribution influences chemical defences in native and introduced Plantago lanceolata populations. **Functional Ecology**, 38(4), 883-896

Silkmoths: olfactory worlds of females and males differ

A team of researchers from the Department of Evolutionary Neuroethology led by Sonja Bisch-Knaden, together with colleagues from the Martin Luther University Halle-Wittenberg, has studied olfaction in female silkmoths. Using electrophysiological methods, they discovered that the antenna, which is specialized in males to detect female pheromones, is particularly sensitive in females to the odor of silkworm excrement. Components of this odor turned out to be a deterrent for mated females, probably allowing them to avoid competition for their own offspring when laying eggs. The responsible sensory neurons are located in hair-like structures called sensilla. In males, the detection of pheromones takes place in a long type of these sensilla, whereas the long sensilla neurons of females detect the odor of larval excrement. The scent of the mulberry tree, the only known silkworm host-plant, on the other hand, is detected by the female silkmoths' sensory neurons in medium-length sensilla.

The study of olfactory perception in female silkmoths revealed an unusual spatial organization of olfactory receptors. There are two families of receptors: ionotropic receptors (IRs) for acids and olfactory receptors (ORs) for various chemical compounds. Contrary to previous assumptions based on studies in *Drosophila melanogaster*, the researchers found that silkmoths have both IRs and ORs in the same neurons in the long sensilla. This co-expression expands the chemical range of olfactory neurons and could improve the detection of important odor mixtures.

The study also highlights the importance of working with more than just one model.

Original Publication:
Schuh, E., et al. (2024). Females smell differently: characteristics and significance of the most common olfactory sensilla of female silkmoths. **Proc. B. Soc. B**, 291: 2023.2578

Female silkmoth (Bombyx mori) on the leaf of a mulberry tree, the only host plant for the offspring of these moths. The combed antennae, which act as the insect's "nose" to detect odors, are clearly visible. The lateral branches of the antennae are covered with thousands of hair-like structures called sensilla, which house the sensory neurons for odor detection.
Photo: Markus Knaden

AWARDS AND EVENT RECOMMENDATION

IMPRS symposium highlights academic excellence and collaboration

Marion Lemoine, Ronja Krüsemer, IMPRS spokesperson Prof. Dr. Holger Schielzeth, Johannes Körnig und Iulia Barutia.
Photo: Anja Kirschner

The symposium of our International Max Planck Research School Chemical Communication in Ecological Systems, held in Dornburg on 17-18 April, provided an excellent platform for scientific exchange and collaboration among all participants. Lively discussions on a wide range of research topics were held throughout the event, highlighting the depth and breadth of the PhD projects undertaken by the doctoral researchers. On the evening of the final day, awards were presented for the best oral and poster presentations.

Prizes for the best talks went to Marion Lemoine and Ronja Krüsemer, both from the Department of Insect Symbiosis. Awards for the two best posters went to Iulia Barutia, Institute of Zoology and Evolutionary Research, University of Jena and Olfactory Coding Research Group, and Johannes Körnig, Department of Insect Symbiosis.

Dr. Andrea Müller (center) at the award ceremony. She is congratulated by Campus Chairman Prof. Dr Peter Zipfel and her doctoral supervisor, Dr Axel Mithöfer, head of the Plant Defense Physiology Research Group at the MPI-CE.
Photo: Tina Peißker

Andrea Müller honored with the Beutenberg Campus Prize

At the Noble Gespräche (Nobel Talks) spring event on 30 May 2024, Andrea Müller received the Beutenberg Campus Science Award for the best dissertation of 2023. Müller conducted experiments on tococa plants in the Peruvian rainforest. These plants live in symbiosis with ants, which defend their host-plants against herbivores. She showed that tococa plants benefit twice from the symbiosis: once from the protection provided by the ants and once from the presence of the ants' food and feces, which have a positive effect on the plants' metabolism. Despite the symbiosis, the plants have retained their own defenses, although these are less effective. Müller discovered two defense substances in leaves with herbivore damage: phenylacetaldoxime (PAOx) and the newly described glucoside, PAOx-Glc, whose biosynthetic pathway and biological function she also elucidated.

https://beutenberg.de/

Save the date: Long Night of the Sciences on 22 November 2024

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The Long Night of Science will take place on 22 November 2024 in Jena. The Max Planck Institute for Chemical Ecology will open its doors to the public! Save the date and look forward to exciting insights into our research.

www.ice.mpg.de

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