FRANKFURT SUMMER SCHOOL

GOETHE UNIVERSITÄT FRANKFURT AM MAIN

Syllabus

Natural and Life Sciences

Frankfurt Summer School 2018

16 July – 10 August

Biodiversity and Global Change

General Outline

Biologists and Geoscientists at the Goethe-University Frankfurt and the Senckenberg Biodiversity and Climate Research Centre aim to understand the dynamics of current and past changes in ecosystems and environments, focusing on a diverse range of organism groups. For many abundant organisms (marine algae, fungi, vertebrates, etc.), surprisingly little is understood about their ecological interactions and ecosystem functions within the context of global change. The aim of this course is to train a new generation of scientists in the interdisciplinary skills needed to investigate fundamental questions about biodiversity, macroecology, evolutionary trends, and their role in quantitative paleoenvironmental reconstructions across large spatial scales and geological time.
During the Frankfurt Summer school students will be trained in techniques across a variety of subjects including:

• Macroevolution - evolutionary change of species in fossils and molecular phylogenies

• Animal Movements in Human Modified Landscapes

• How fungi are ecosystem service providers! Integrative research on diversity, systematics and applied aspects of fungi

• Mankind and the biosphere in the past and the present

• How micro-organisms are used for reconstructing environments! Introduction into marine biodiversity, paleoceanography and paleoclimatology

The lectures will be held in English in the Biosciences and Geosciences Buildings - Campus Riedberg. The Coordinator of the Natural and Life Sciences program is Prof. Dr. Jens O. Herrle.

Seminars

Week 1

17 July (9:30-13:00; 14:30-16:00): Campus Riedberg (Max-von-Laue-Straße 13), Biologicum, Wing D, 2nd floor, MSc.-Room "No fungi - no future! The importance of fungi in ecosystems and for humans" (Prof. Dr. Meike Piepenbring, Dr. Ralph Mangelsdorff)

Three lectures provide a brief introduction to basics of mycology, the presentation of systematic concepts, important systematic groups, and ecological aspects. The knowledge is applied in presentations of participants on useful fungi in their home country, for a glass cabinet quiz, and on specimens that will be examined by stereo- and light microscopy.

Teaching goals: After participating in this module, students will be able

- to distinguish genera, orders, and divisions of important useful fungi
- to cite numerous applied contexts in which fungi are useful
- to explain why and how fungi are essential for ecosystem functions

18 July (14:30-16:00): Lecture Series, Campus Westend, Casino Renate-von-Metzler-Saal
„Selected Aspects of Human Evolution"
(Prof. Dr. Bruno Streit)

Early species of Man (genus *Homo*), some 2-3 million years ago, adapted to fast and far-reaching marching and running, invented tools and the use of fire, but also started to migrate out of their ancestral continent of Africa into Eurasia. Later, modern Homo sapiens, arising some 200.000 years ago, turned out to become the most effective migratory species on earth and eventually colonized and altered all inhabitable regions of the planet, using technical skills and flexible social structures. The results were dramatical changes in landscapes and heavy losses of biodiversity since at least some 50 to 60.000 years ago, after this species had left Africa. By developing agriculture and livestock as resource bases (since approx. 10.000 years) and building first cities, various cultural societies developed hierarchical social structures with kingdoms, armies and warfare. Intensified spreading and mixing of peoples and languages, cultures and skills, ideas and religions, frequently associated with wars, suppressions and forced mixing or expelling of populations have become typical attributes of modern societies and nations and have been well-known since Antiquity, some 2 to 3.000 years ago. This new way of interactions, very different from the ancestral behavior of early human species, was associated with a gradual increase in world population size, which started to literally "explode" in the last 200 years or so.

19 July (09:30-13:00): Senckenberg Museum (Senckenberganlage 25), Entrance Hall
„Evolutionary Biology of Organisms"
(Prof. Dr. Bruno Streit)

The seminar will provide an overview on evolutionary biology, focusing on both, morphological and genetical aspects. Selected items will be explained and discussed in the Senckenberg exhibition halls.

Week 2

23 July (9:30-13:00): Campus Riedberg (Max-von-Laue-Straße 13), Biologicum Wing C, 3rd floor, "Masterraum"
"The Environemental change from early Holocene to the present"
(Prof. Dr. Bruno Streit)

During the cold periods of the Pleistocene, which came to an end some 12.000 years before present, large areas of the Northern Hemisphere were covered with either ice, tundra with permafrost soils or some taiga-like forests. In that period, large amounts of loess (a wind-driven sediment) was deposited, e.g. in the area where our course is taking place. With the beginning of the Holocene, woods of various tree species (but not yet the beech) were spreading in the area of Central Europe, populated by post-glacial nomadic hunter and gatherer populations of *Homo sapiens*. Starting around 5500 BC the neolithic revolution, with elements of pottery, of agriculture and livestock started in our area and was the beginning of a fundamental change of the landscape, which is continuing still today.
On a short excursion we will walk from the medieval village of Niederursel to one of the most modern city parts of Frankfurt, the Riedberg with its numerous buildings constituting the Science City.
The gradual change of the landscape and of human activities during the centuries will be exemplifie and discussed.

24 July (9:30-13:00): Senckenberg Biodiversity and Climate Research Center (BiK-F), Room CIP 2.20 "Animal Movements in Human Modified Landscapes"
(Jun.-Prof. Dr. Thomas Müller, Theresa Stratmann)

Animal migrations have fascinated humans for centuries, but it was not until the advent of GPS tracking technology that we could really begin to understand this phenomenon. This new wealth of high resolution movement data of animals has defined a new field of biology called movement ecology. Movement ecology tries to understand why and how animals move within landscapes. This is critical, as much of the world's biodiversity – from butterflies to marine mammals to birds to ungulates - exists only because of its ability to move long distances.
The first day will comprise of an introduction to movement ecology, highlighting various case studies on the role of global change in re-shaping animal movements and how a better understanding of animal movement is key to conserving animals in human modified landscapes This will be followed by a paper discussion. The goal for the first day is to highlight and discuss the kind of questions movement ecology can answer.
The second day will comprise of an introduction to Individual Based Models and a mini-experiment that students will conduct in groups. Here students will implement a computer simulation model that will allow them to explore the effects of human landscape modification such as habitat fragmentation on animal movement and population survival. The simulation model will implement grassland landscapes and moving herbivores and students will manipulate animal movement and landscape properties to explore their effects on population dynamics.
The goal is for students to address fundamental questions about population viability in fragmented landscapes and use simulation models to answer questions regarding effect of human landscape modifications. Groups will then present their results and we will end the seminar discussing the questions and the model output so students can take away critical ideas about animal movements in human modified landscapes.

26 July (9:30-13:00): Senckenberg Biodiversity and Climate Research Center (BiK-F), Room CIP 2.20 "Animal Movements in Human Modified Landscapes"
(Jun.-Prof. Dr. Thomas Müller, Theresa Stratmann)
Case studies in movement ecology.

Week 3

30 July (9:30-13:00): Senckenberg Biodiversity and Climate Research Center (BiK-F), Room CIP 2.20
"Macroevolution - evolutionary change of species in fossils and molecular phylogenies"
(Dr. Susanne Fritz)

Macroevolution describes patterns and processes of evolution above the species level. Instead of focusing on an individual species, e.g. how populations of a species of finch might change over time, macroevolution zooms out on the tree of life to assess the diversity and diversification of entire groups of species, such as all finches (a family, the Fringillidae), or even all birds (the class Aves). The dominant processes shaping macroevolutionary patterns are speciation, extinction, and the evolution of species' traits. These processes generate patterns that can be studied with fossils, describing the macroevolutionary history of species groups and higher taxa over geological timescales; they can also be studied with modern phylogenetic comparative methods, which usually focus on living species and reconstruct macroevolutionary history using DNA and modern phylogenetics or phylogenomics.

Both perspectives will be covered in this course through short lectures and computer exercises. The first part of the course will introduce the basics of the field, giving students a short overview over the fundamental macroevolutionary processes and the observed patterns such as the evolution of multicellular life since the Cambrian explosion until today. The tools that paleontologists use to describe diversity patterns and infer diversification processes from the fossil record will be introduced, and there will be a small practical exercise on the computer to estimate diversification rates from an example dataset of large mammals in the European Neogene. The goal is for students to gain experience in basic diversity analyses, and to be able to critically discuss the advantages and disadvantages of working with the fossil record.

31 July (9:30-13:00; 14:30-16:00): Senckenberg Biodiversity and Climate Research Center (BiK-F), Room CIP 2.20
"Macroevolution - evolutionary change of species in fossils and molecular phylogenies"
(Dr. Susanne Fritz)

The second part of the course will provide the students with basic knowledge over the different ways that evolutionary biologists working on living species infer macroevolutionary processes. Examples will include inferences of global diversification patterns from phylogenies of birds and mammals. A computer exercise will enforce the theoretical background with hands-on practical knowledge of the necessary methods, using molecular phylogenies of the same group of large mammals as the fossil exercise. The goal is for students to gain experience in basic phylogenetic comparative methods, and to be able to critically discuss the advantages and disadvantages of working with phylogenetic reconstructions based on living species. The course will conclude with a direct comparison and discussion of the two introduced approaches to macroevolution, and a short excursion to the Senckenberg Museum to illustrate the take-away messages.

From a biological and ecological viewpoint, the increasing population densities were possible by improved food production methods, but frequently also overexploitations of resources (including, e.g., soil erosions and desertifications) during the whole post-glacial period already. The successively new sources and techniques circumvented limits set by the natural carrying capacity, typical for all other species. The overcome of natural diseases since the 20th century, of many tribal conflicts and the destruction of population self-regulation mechanisms in many indigenous peoples led to the current and future overpopulations, which, according to UN data, for the 21st century will be most prominent in Africa and will lead to further strong migration pressures. Mankind urgently needs new and holistic approaches to find solutions.
The presentation is conceived to be understood by and provide a discussion bases for students of Natural and Life Sciences, of Psychology, and of Legal Studies.

2 August (10:00-12:30): Campus Riedberg, (Max-von-Laue-Straße 3) Visit of the Max-Planck-Institute of Biophysics
Meeting at the front door of the MPI. Talk and guided tour

Week 4

6 August (9:30-13:00) Campus Riedberg (Altenhöferallee 1), Geoscience Building, Room 3.102
"Introduction into marine biodiversity, paleoceanography and paleoclimatology"
(Prof. Dr. Jörg Bollmann, Prof. Dr. Jens O. Herrle)

Understanding processes within the Earth system is crucial to develop concepts for assessing global environmental issues such as current climate change. Earth history provides exceptional examples of rapid environmental change and holds unique information, for example, on how the human evolution has been affected by a changing environment. The goal of this course is to gain insights into fundamental concepts of the development of microorganism based environmental proxies, such as water paleo-temperature and paleo-salinity, and their application in the geological past. Students will be introduced to tools, data, and ideas relevant to environmental reconstruction including scanning electron and light microscope techniques, morphometric analysis and data analysis.

7 August (9:30-13:00, 14:30-16:00) Campus Riedberg (Altenhöferallee 1), Geoscience Building, Room 3.102
(Prof. Dr. Jörg Bollmann, Prof. Dr. Jens O. Herrle)
Application and practical

9 August (9:30-13:00) Campus Riedberg, (Altenhöferallee 1), Geoscience Building, Room 3.102
(Prof. Dr. Jörg Bollmann, Prof. Dr. Jens O. Herrle)
Application and practical

10 August (9:30-13:00) Campus Riedberg, (Altenhöferallee 1), Geoscience Building, Room 3.102
(Prof. Dr. Jörg Bollmann, Prof. Dr. Jens O. Herrle)
Discussion of results. Test of the lectures and practical.

General Information on the track Natural and Life Sciences

Duration of the seminar:
50 hours including lecture series and a visit to the Max-Planck-Institute for Biophysics.

Attendance:
Participants have to attend at least 80 % of the classes.

Evaluation:
The learning achievements will be verified by two exams of about 45 minutes. The first exam will cover the material of week 1 and 2 and the second exam the material of week 3 and 4 of the Summerschool (e.g., multiple choice, short answers, ...).

Credit points:
The participants will receive 6 CPs per module (corresponding to twelve morning lectures from 9:30-13:00, three afternoon lectures from 14:30-16:00, and additional home learning.

GRADE	GRADE POINT VALUE	PERCENTAGE	DEFINITION
A+	4	90-100	Excellent
A	4	85-89	
A-	3.7	80-84	
B+	3.3	77-79	Good
B	3	73-76	
B-	2.7	70-72	
C+	2.3	67-69	Adequate
C	2	63-66	
C-	1.7	60-62	
D+	1.3	57-59	
D	1	53-56	Marginal
D-	0.7	50-52	
F	0	0-49	Inadequate; no credit obtained

Lecturers

Prof. Dr. Jörg Bollmann
Goethe-University Frankfurt
University of Toronto Department of Earth Sciences
E-Mail: bollmann@es.utoronto.ca
Website: http://chert.geology.utoronto.ca/faculty/jorg-bollmann/

My research interest is a more rigorous understanding of the relationships between the geosphere and the biosphere and their variability during the history of our planet. My research focus is Marine Geobiology, particularly the history of the global oceans including paleoecology, paleobiogeography and the evolution of calcareous marine microorganisms. In addition, I am developing innovative methods especially fully automated microscopes for identification, counting and morphometry of calcareous microorganisms.

Dr. Susanne Fritz
Senckenberg Biodiversity and Climate Research Centre (BiK-F), Senckenberg Gesellschaft für Naturforschung
& Goethe-University Frankfurt, Faculty of Biosciences, Institute for Ecology, Evolution and Diversity
Email: sfritz@senckenberg.de
Phone: +49 69 75421803
Website: http://www.bik-f.de/root/index.php?page_id=772

Since 2014, Dr Susanne Fritz is an Emmy Noether junior research group leader at Senckenberg and Goethe-University. She is an evolutionary biologist and biogeographer who studies ecology and evolution on large spatial, temporal, and taxonomic scales with both living and extinct species, lately focusing on large terrestrial mammals and passerine birds through the Neogene until today. She is interested in the processes underlying large-scale biogeographic and phylogenetic patterns, the relationships of species and clades with their abiotic environment, and the consequences of increasing human impacts on past, current, and future biogeographic and phylogenetic patterns.

Prof. Dr. Jens O. Herrle
Goethe-University Frankfurt
Faculty of Geosciences / Geography
Institute of Geosciences
E-Mail: jens.herrle@em.uni-frankfurt.de
Website:http://www.geologie.uni-frankfurt.de/Staff/Homepages/Herrle/Herrle.html

Since 2009 Dr. Jens Herrle is Professor of Paleontology & Biogeochemistry at the Goethe-University Frankfurt and specializes in Ceno- and Mesozoic process studies of extreme greenhouse and icehouse conditions. His research focuses on the development and application of calcareous microorganisms and geochemical-based proxies for deciphering the history of the oceans. His research includes bio- and chemostratigraphic, paleoceanographic and paleoecologic (including culture studies) studies to gain rigorous insights into causes and consequences of major perturbations in the Earth system as documented, for example, by the burial of massive carbon-rich sediments (Oceanic Anoxic Events) during the Mesozoic.

Dr. Ralph Mangelsdorff
Goethe-University Frankfurt
Faculty of Biosciences Department of Mycology
E-Mail: mangelsdorff@bio.uni-frankfurt.de

Dr. Ralph Mangelsdorff studied biology in Frankfurt am Main and Bayreuth (Germany) where he specialized in systematic botany, mycology and ecology. Since 2004 he is lecturing botany and mycology at the Goethe University of Frankfurt, and since 2010 he mainly teaches botany, mycology, zoology and ecology for Geographers and Geologists. Between 2004 and 2007 he repeatedly lectured at the Universidad Nacional de Chiriquí (UN- ACHI) in David, Panamá, and in 2012 and 2014 at the Universidad Técnica Particular de Loja in Loja, Ecuador. He is especially interested in mutualistic and parasitic relationships between fungi, plants and animals, and in teaching biology.

Jun.-Prof. Thomas Müller
Robert Bosch Juniorprofessur
Goethe-University Frankfurt
Faculty of Biosciences
Institute for Ecology, Evolution and Diversity
E-mail: thomas.mueller@senckenberg.de
Website:http://www.bik-f.de/root/index.php?page_id=774
LabWebsite:http://www.bik-f.de/root/index.php?page_id=1077

Thomas Mueller is a Junior Professor for Movement Ecology and Biodiversity Conservation at the Goethe University Frankfurt, Germany and the Senckenberg Biodiversity and Climate Research Centre. His research focuses on movement ecology. It ranges from theoretical approaches to better understand movement behaviors to applied questions that emerge when ecosystem functions that moving animals provide are affected by anthropogenic developments.
He earned a Diploma degree in Biology at the Phillips University Marburg, Germany and a PhD at the University of Maryland, USA. He has worked in various systems from studying climate change effects on penguin populations in Antarctica to social learning of migration behavior of reintroduced whooping cranes in the eastern USA. In 2013 he was awarded the Robert Bosch Junior Professorship for research into “Sustainable development and long-distance animal movements”.

Prof. Dr. Meike Piepenbring
Goethe-University Frankfurt
Faculty of Biosciences Department of Mycology
E-Mail: Piepenbring@em.uni-frankfurt.de
Website:
http://www.bio.uni-frankfurt.de/43924404/ak-piepenbring

Prof. Dr. Meike Piepenbring is a botanist and mycologist who received training at the universities of Cologne (Germany), Clermont-Ferrand (France), and Tübingen (Germany). She is professor of mycology at the Goethe University of Frankfurt since 2001, interrupted by two years of guest professorship at the Universidad Autónoma de Chiriquí in Panama with support by the German Academic Exchange Service. She is fascinated by fungal diversity, in particular plant parasitic microfungi. Together with students and collaborators she published more than 100 scientific papers, mostly on new species, new genera, phylogeny, fungal diversity and ecology. Her most important contribution to teaching is a textbook entitled “Introduction to mycology in the tropics”, published by APS Press in 2015.

Theresa Stratmann
Goethe-University Frankfurt,
Faculty of Biosciences
Institute for Ecology, Evolution and Diversity
Email: theresa.stratmann@senckenberg.de
Website:http://www.bik-f.de/root/index.php?page_id=1075

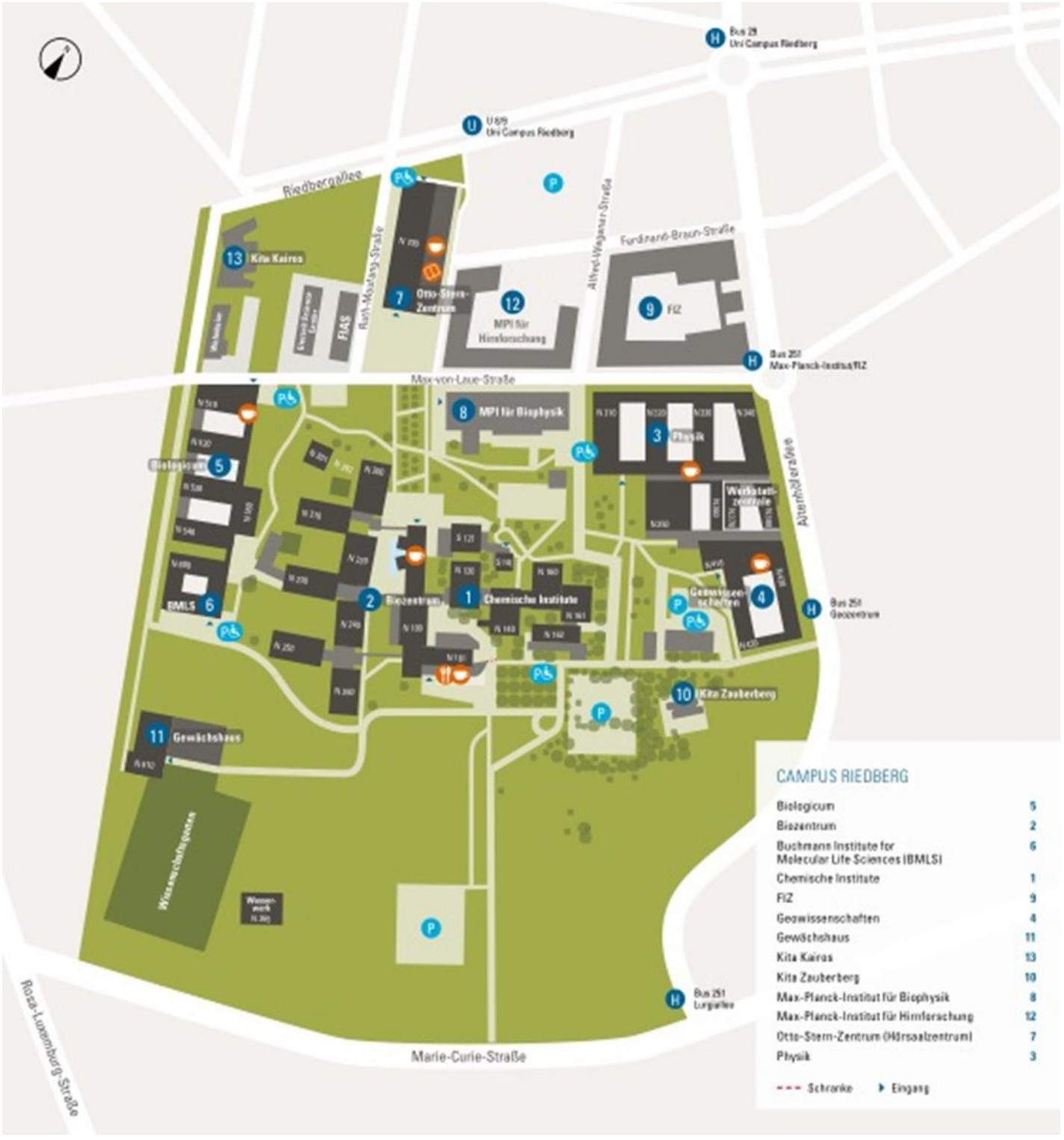
Theresa Stratmann is a PhD student at the Goethe University Frankfurt and the Senckenberg Biodiversity and Climate Research Centre. Her research interest is in conservation biology and how we can use math and modeling to make better conservation decisions. Theresa's PhD work focus on implementing an individual based simulation model of vegetation and herbivore feedbacks that can be used to answer questions about the importance of movement in determining carrying capacity in unpredictable and fragmented landscapes. In addition the model can be used to shed light on the nonequilibrium/ equilibrium rangeland dynamics debate which asks if vegetation communities are controlled by herbivores or climate.

Prof. Dr. Bruno Streit Goethe-University Frankfurt
Faculty of Biosciences
Department of Ecology and Evolution
E-Mail: streit@bio.uni-frankfurt.de
Website: www.bio.uni-frankfurt.de/ee

Bruno Streit is currently Senior Professor of Ecology and Evolution at the Institute of Ecology, Evolution and Diversity. He originally did his research on limnology, ecotoxicology, and population biology. Later he focused on evolutionary biology and biodiversity in the context of the Global Change. He originally studied at Basel/Switzerland (Diploma) and Konstanz/Germany (PhD), was Postdoc and Assistant Professor for several years at Konstanz and later at Basel again. He then went to Stanford University as a Research Fellow, from here he finally came to Frankfurt in 1985 to take over a Full Professorship of Ecology and Evolution. Currently, his major interest is in the interaction between nature and human civilization and its effect on global biodiversity change.

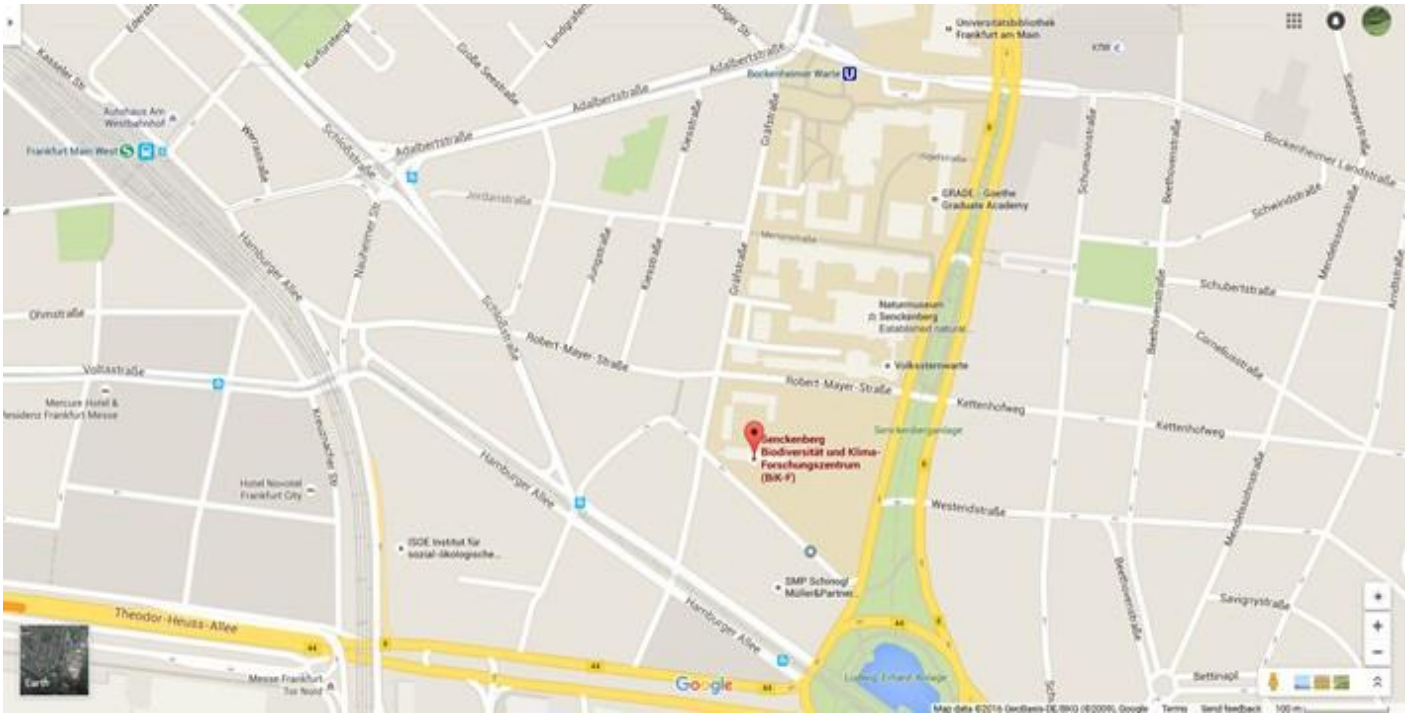
Course locations

Campus Riedberg



Biologicum, Max-von-Laue-Str. 9, 60438 Frankfurt am Main
Geoscience Building, Altenhöferallee 1, 60438 Frankfurt am Main

Biodiversity and Climate Research Center (BiK-F)



The course room is on the second floor. If you enter from the main entrance on Georg-Voigt Straße 14-16, go up one flight of stairs to the second floor. You will then see a kitchen and the computer lab is the next room to your right (Room: CIP 2.20).

Senckenberg Biodiversity and Climate Research Center (BiK-F) Georg-Voigt-Straße 14-16
60325 Frankfurt am Main