OEP Biology

Module book

December 2023

UNIVERSITÄT BONN

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Obligatory modules

Biodiversity and Evolution

OEP-M1

UNIVERSITÄT BONN

1. Content and intended learning outcomes

Content	A weekly lecture will explain phylogeny and evolution of multicellular animals and of the functional constrains that governed their evolution. A second weekly lecture will introduce into plant diversity and evolution. During one-week field trip the students will learn how to work with species, how to systematically analyze them and how to identify them.
Learning outcomes	Overview of the current phylogenetic relationships in plants and animals, introduction into animal and plant diversity, training in systematics, species identification and assessment of literature sources

2. Teaching and learning methods

	Type of instruction	Topic	Language of instruction	Group size	Weekly contact time*	Workload [h]
	V	Plant biodiversity	en.	50	2	120
	V	Animal Diversity & Evolution	en.	50	2	120
	S, E	Field trip on biosystematics	en.	25	2,5	60

3. Prerequisites for the module

compulsory	none
recommended	none

4. Degree program allocation

	Study program	compulsory/ elective	Semester
	MSc OEP-Biology	compulsory	1

5. Requirements for the award of credits (ECTS)		6. Credits
Required achievements	Oral presentation (Präsentation), scientific exposé (data sheets)	**10**
Assessment (incl. weighting) and examination language	Written exam (Klausur) (100%), en.	

7. Frequency				8. Workload	9. Duration
Winter semester	☒	Winter and summer semester	☐	**300h**	**1 sem.**
Summer semester	☐				

Module coordination

Teacher	Prof. Dr. T. Bartolomaeus. Prof. Dr. M. Weigend, Dr. J. von Döhren, Dr. M. Koch
Module coordinator	Prof. Dr. T. Bartolomaeus
Institute/Department	IEZ, NEES/Biologie

Further information

(Reading lists, information links etc.)	Additional information: The module includes a field trip early during the winter term, preferably in the first week prior to the onset of lectures Recommended Readings Literature will be provided during the module via ecampus

* SWS

Fundamentals of Evolutionary Biology

OEP-M2

UNIVERSITÄT BONN

1. Content and intended learning outcomes

Content	The module consist of lectures, practicals, and seminars. It covers largely the response of animals and plants to environmental constraints, introduces into terrestrial and marine systems, climate, population and community ecology as well as the theory of evolution and the role of natural and sexual selection during evolution. The lectures on phylogenetics and Paleobiology provide insight into the ancient situation of our planet, extinct ecosystems, animal and plant groups and mass extinctions.
Learning outcomes	Basic knowledge in aminal and plant ecology, biological answers to physiological contraints evolution of physiological properties in animals, evolutionary theory and current toics of phylogenetics

2. Teaching and learning methods

Type of instruction	Topic	Language of instruction	Group size	Weekly contact time*	Workload [h]
V	Evolutionary Physiology	en.	50	2	60
S	Evolutionary Physiology	en.	50	2	60
V	Ecology and Evolution	en.	50	2	60
V	Phylogenetics & Paleobiology	en.	50	2	60
prÜ	Character Coding & Cladistics	en.	50	1	30
S	Paleontology	en.	50	1	30

3. Prerequisites for the module

compulsory	none
recommended	none

4. Degree program allocation

Study program	compulsory/ elective	Semester
MSc OEP-Biology	compulsory	1

5. Requirements for the award of credits (ECTS) / 6. Credits

Required achievements	Oral presentation (Präsentation)	**10**
Assessment (incl. weighting) and examination language	Written exam (Klausur) (100%), en.	

7. Frequency				8. Workload	9. Duration
Winter semester	☒	Winter and summer semester	☐	**300h**	**1 sem.**
Summer semester	☐				

Module coordination

Teacher	Prof. Dr. G. von der Emde, PD Dr. L. Podsiadlowski (ZFMK), Prof. Dr. L. Schreiber, Prof. Dr. T. Bartolomaeus, PD Dr. J. Mogdans, PD Dr. V. Schlüssel, Prof. Dr. T. Martin, Prof. Dr. J. Rust
Module coordinator	Prof. Dr. G. von der Emde, Prof. J. Rust
Institute/Department	IEZ, NEES/Biologie, ZFMK

Further information

(Reading lists, information links etc.)	Recommended Readings will be deposited on ecampus. The seminar will be held in two consecutive groups

* SWS

Scientific Communication

OEP-M3

UNIVERSITÄT BONN

1. Content and intended learning outcomes

Content	Students train the practice and theory of communication in the evolutionary sciences, they learn how to write abstracts and publications and how to design posters and presentations
Learning outcomes	Different ways to communicate in science, like talks, abstracts, papers, reviews are taught and trained

2. Teaching and learning methods

	Type of instruction	Topic	Language of instruction	Group size	Weekly contact time*	Workload [h]
	V	Scientific Communication	en.	50	1	30
	S	Scientific Communication	en.	50	1	30
	prÜ	Scientific Communication	en.	50	4	90

3. Prerequisites for the module

compulsory	none
recommended	none

4. Degree program allocation

	Study program	compulsory/ elective	Semester
	MSc OEP-Biology	compulsory	1

5. Requirements for the award of credits (ECTS)		6. Credits
Required achievements		**5**
Assessment (incl. weighting) and examination language	oral presentation (Referat) 40%, en. assignment (wiss. Schreibübung), 40%, en. abstract (wiss. Zusammenfassung) 10%, en. 2 methods sheets (Methodik-Arbeitsblätter) 5% each, en.	

7. Frequency				8. Workload	9. Duration
Winter semester	☒	Winter and summer semester	☐	**150h**	**1 sem.**
Summer semester	☐				

Module coordination

Teacher	Prof. Dr. T. Bartolomaeus, Prof. Dr. M. Weigend, Dr. C. Gee
Module coordinator	Prof. Dr. T. Bartolomaeus
Institute/Department	Paläontologisches Institut/Geowissenschaften

Further information

(Reading lists, information links etc.)	Recommended Readings will be deposited on ecampus. The seminar will be held in two consecutive groups

* SWS

Biological Colloquium

OEP-M4

UNIVERSITÄT BONN

1. Content and intended learning outcomes

Content	In the biological colloquium scientists of UBN and from other universities present their ongoing research to students of the OEP programme and all others interested. OEP students should learn how scientific content is presented in different research fields. This colloquium is a unique opportunity for students to take a look at ongoing research in different labs, learn about new approaches, and potential avenues for their own research.
Learning outcomes	Different ways to communicate in science, like talks, abstracts, papers, reviews are taught and trained. Students can get in touch with scientists in order to shape their own research agenda, find suitable places for lab rotations, and other topics of their choice.

2. Teaching and learning methods

	Type of instruction	Topic	Language of instruction	Group size	Weekly contact time*	Workload [h]
	K	Biological colloquium	en.	50	2	60

3. Prerequisites for the module

compulsory	none
recommended	none

4. Degree program allocation

	Study program	compulsory/ elective	Semester
	MSc OEP-Biology	compulsory	1 - 3

5. Requirements for the award of credits (ECTS)		6. Credits
Required achievements	10 abstracts (100 words minimum; One for each talk) in English	**2**
Assessment (incl. weighting) and examination language		

7. Frequency				8. Workload	9. Duration
Winter semester	☐	Winter and summer semester	☒	**60h**	**2 sem.**
Summer semester	☐				

Module coordination

Teacher	Invited speakers from UBN and other universities
Module coordinator	Prof. Dr. A. Blanke
Institute/Department	Biologie, ZFMK, Geowissenschaften

Further information

(Reading lists, information links etc.)	The students have to participate in 10 biological colloquia and they are free to attend more during their studies. Student participation will be documented. Successful attendance requires to hand in 10 abstracts (one of each talk) out of the full breadth of talks they attended. It is strongly recommended that students take appropriate notes during the talks in order to hand in appropriate abstracts. Note that copies of the original abstracts of the lecturers are not sufficient.

* SWS

Disputation (Defense)

OEP-M5

UNIVERSITÄT BONN

1. Content and intended learning outcomes	
Content	Students defend their own research results of the Master's thesis; students should present an overview of current and past biodiversity as well as evolutionary constraints and processes. The disputation should not last longer than 1 hour und consists of an oral presentation not longer than 30 minutes and a subsequent defense.
Learning outcomes	Ability to defend the results of the Master thesis and to communicate in Science

2. Teaching and learning methods

	Type of instruction	Topic	Language of instruction	Group size	Weekly contact time*	Workload [h]
	S	Defense colloquium of Master thesis	en.	30	1	90

3. Prerequisites for the module

compulsory	OEP-M4
recommended	none

4. Degree program allocation

	Study program	compulsory/ elective	Semester
	MSc OEP-Biology	compulsory	4

5. Requirements for the award of credits (ECTS)		6. Credits
Required achievements	oral presentation (Präsentation)	**3**
Assessment (incl. weighting) and examination language	oral examination (mündliche Prüfung) (100%)	

7. Frequency				8. Workload	9. Duration
Winter semester	☐	Winter and summer semester	☒	**90h**	**2 sem.**
Summer semester	☐				

Module coordination	
Teacher	All lecturers of the OEP program
Module coordinator	Resp. head of the Prüfungsausschuss MSc OEP-Biology
Institute/Department	Biologie, ZFMK, Geowissenschaften

Further information	
(Reading lists, information links etc.)	Additional information: The students have to participate the defenses of their fellow students

* SWS

Elective modules

Elective area A

Method-oriented modules

Analysis of form and function in living systems **OEP-A01 INAKTIV**	UNIVERSITÄT BONN

1. Content and intended learning outcomes	
Content	
Learning outcomes	

2. Teaching and learning methods						
	Type of instruction	Topic	Language of instruction	Group size	Weekly contact time*	Workload [h]
	V		en.			
	S		en.			
	Ü		en.			

3. Prerequisites for the module	
compulsory	OEP-M2
recommended	none

4. Degree program allocation			
	Study program	compulsory/ elective	Semester
	MSc OEP-Biology	elective	2 o. 3

5. Requirements for the award of credits (ECTS)		**6. Credits**
Required achievements	Scientific exposé (data sheet)	**10**
Assessment (incl. weighting) and examination language	Oral exam (Mündliche Prüfung) (100%), en.	

7. Frequency				**8. Workload**	**9. Duration**
Winter semester	☒	Winter and summer semester	☐	**300h**	**1 sem.**
Summer semester	☒				

Module coordination	
Teacher	Prof. Dr. A. Blanke (IEZ)
Module coordinator	Prof. Dr. A. Blanke (IEZ)
Institute/Department	Biologie

Further information	
(Reading lists, information links etc.)	Recommended Readings

* SWS

Bioinformatics for Master Students – Beginner's course

OEP-A02

UNIVERSITÄT BONN

1. Content and intended learning outcomes

Content	The students will learn how to store, access, and manipulate data in the different types of variables (i.e., scalars, lists, dictionaries) that Python supports. Using loops (e.g. for, while) and control structures (e.g., if/elif/else), they will then develop the skills to tackle more complex problems. By introducing filehandles, the students will discover how to retreive and to store data directly from/in a file, whose content they will then parse out by using regular expressions. The students will be tought the concept and the benefits of subroutines and modules, which will allow them to build larger programs and to reuse their code, or that of others. The latter will be excersized using the vast collection of free tools and scripts from the python bioinformatics community. Basic bioinformatics tools for sequence comparison (BLAST) and alignment (MAFFT) will also be used and controlled from python scripts .
Learning outcomes	The course aims to teach students the skills to accomplish the tasks needed for many of today's bioinformatic challenges, such as extracting data from a program's output file, analysing data in a way, that no program provides so far, or simply handling and proceesing large datasets. Focusing on realistic examples –analyses of DNA and protein sequences in phylogenetic and genome projects – the students will develop programming skills in the popular and easy to learn scripting language Python. Students will apply their newly acquired programming skills to access and control external programs, such as database management systems, sequence alignment programs, and programs of the Basic Local Aligment Search Tool (BLAST), as well as how to automatically retrieve data from the world wide web.

2. Teaching and learning methods

	Type of instruction	Topic	Language of instruction	Group size	Weekly contact time*	Workload [h]
	V	Bioinformatics	en.	12	2	90
	P	Bioinformatics	en.	12	7	210

3. Prerequisites for the module

compulsory	OEP-M2
recommended	none

4. Degree program allocation

	Study program	compulsory/ elective	Semester
	MSc OEP-Biology	elective	2 o. 3

5. Requirements for the award of credits (ECTS) / 6. Credits

Required achievements	Scientific exposé (data sheet)	**10**
Assessment (incl. weighting) and examination language	Written exam (Klausur) (100%), en.	

7. Frequency				8. Workload	9. Duration
Winter semester	☒	Winter and summer semester	☐	**300h**	**1 sem.**
Summer semester	☒				

Module coordination

Teacher	Prof. Dr. B. Misof (ZFMK), Dr. L. Podsiadlowski (ZFMK), Dr. A. Donath (ZFMK)
Module coordinator	Prof. Dr. B. Misof
Institute/Department	Biologie, ZFMK

Further information

(Reading lists, information links etc.)	Recommended Readings Stevens, Boucher, 2015: Python programming for Biology Richard Wagstaff, 2013 Python in a day. CreateSpace. ISBN-13: 978-1490475578 SHD Haddock, C Dunn, 2011. Practical computing for biologists. ISBN-13: 978-0878933914

* SWS

Beginner's course: Programming in C/C++

OEP-A03

UNIVERSITÄT BONN

1. Content and intended learning outcomes

Content	This beginner's course introduces into the programming language C/C++. In a first part the students first learn the basics of C. Students will learn the basics of the programming language C/C++ as well as how to design and devise algorithms for solving simple problems. At the end of the course they should be able to write small command line programs to analyze their data sets and to simulate simple procedures in natural or social studies.
Learning outcomes	Knowing how to write simple programs for the analysis of data sets has become a key competence in natural and even in social sciences.

2. Teaching and learning methods

	Type of instruction	Topic	Language of instruction	Group size	Weekly contact time*	Workload [h]
	V	Programming in C/C++	en.	12	2	30
	P	Programming in C/C++	en	12	4	120

3. Prerequisites for the module

compulsory	OEP-M2
recommended	none

4. Degree program allocation

	Study program	compulsory/ elective	Semester
	MSc OEP-Biology	elective	2 o. 3

5. Requirements for the award of credits (ECTS)		6. Credits
Required achievements	Scientific exposé (data sheet)	**5**
Assessment (incl. weighting) and examination language	Written exam (Klausur) (100%), en.	

7. Frequency				8. Workload	9. Duration
Winter semester	☒	Winter and summer semester	☐	**150h**	**1 sem.**
Summer semester	☒				

Module coordination

Teacher	Dr. C. Mayer (ZFMK)
Module coordinator	Dr. C. Mayer (ZFMK)
Institute/Department	Biologie, ZFMK

Further information

(Reading lists, information links etc.)	Additional information: Students from all subjects should be able to follow this course. Recommended Readings Martin Schader, Stefan Kuhlins, Programmieren in C++ Bjarne Stroustrup, Einführung in das Programmieren in C++ Ulrich Breymann, C++, Eine Einführung Nicolai Josuttis, Objektorientiertes Programmieren in C++ Online material such as: http://velociraptor.mni.fh-giessen.de/Programmierung/progI.pdf

* SWS

Theory and Practice of Phylogenetic Systematics

OEP-A04

UNIVERSITÄT BONN

1. Content and intended learning outcomes

Content	Building on a good knowledge in genetics, this course aims to provide a broad understanding of the theoretical concepts used in molecular systematics, ranging from the alignment of molecular sequences, BLAST searches, models of sequence evolution, measures of genetic distances and most important the different methods/algorithms used for the reconstruction of phylogenetic trees. Furthermore, participants will learn how to compute and interpret phylogenetic support values. Computer exercises are an integral component of this course. Participants will learn how to apply their theoretical knowledge when using computer programs to analyze molecular data sets. Every participant will give a presentation in English.
Learning outcomes	The students will get a broad overview over the theoretical concepts used in the field of molecular systematics and how these concepts are applied - using computer programs - to real data sets. It will be shown why the knowledge of these theoretical aspects is necessary for a successful analysis of molecular data sets.

2. Teaching and learning methods

	Type of instruction	Topic	Language of instruction	Group size	Weekly contact time*	Workload [h]
	V	Phylogenetic systematics	en.	20	4	120
	P	Phylogenetic systematics	en.	20	4	120
	S	Phylogenetic systematics	en.	10	2	60

3. Prerequisites for the module

compulsory	OEP-M2
recommended	none

4. Degree program allocation

	Study program	compulsory/ elective	Semester
	MSc OEP-Biology	elective	2 o. 3

5. Requirements for the award of credits (ECTS) / 6. Credits

Required achievements	written report (Protokoll) oral presentations (Präsentationen) scientific exposé (data sheet)	**10**
Assessment (incl. weighting) and examination language	written exam (Klausur) (100%), en.	

7. Frequency				8. Workload	9. Duration
Winter semester	☒	Winter and summer semester	☐	**300h**	**1 sem.**
Summer semester	☒				

Module coordination

Teacher	Dr. C. Mayer (ZFMK), Dr. E. Bärmann (ZFMK), Dr. M. Espeland (ZFMK)
Module coordinator	Dr. C. Mayer (ZFMK)
Institute/Department	ZFMK, Biologie

Further information

(Reading lists, information links etc.)	Additional information: The module requires a good knowledge in genetics. Recommended Readings Knoop & Müller 2006: Gene und Stammbäume, Elsevier Wägele, Wolfgang 2005: Foundations of Phylogenetic systematics, Pfeil Verlag Lemey, Salemy et al. 2009: The phylogenetic handbook, Cambridge Univ. Press Page, R.D., Holmes, E., Molecular Evolution, Wiley-Blackwell Li, Wen-Hsiung, Molecular Evolution, Sinauer Associates, Inc. Felsenstein, Inferring Phylogenies, Sinauer Associates, Inc. Hillis and Moritz, Molecular Systematics, Sinauer Associates, Inc.

* SWS

Principles of Taxonomy: Weekend Seminar

OEP-A05

UNIVERSITÄT BONN

1. Content and intended learning outcomes

Content	This seminar focuses on general principles of taxonomy and classification including the zoological nomenclature and scientific theory, procedures and methods related to taxonomy. It provides not only the basic skills for a taxonomist but also introduces into newest and cutting edge methods of species delimitation where classical "Old School" knowledge is linked with modern hypothesis-based science. Lectures will provide an overview on the history of taxonomy, species concepts, zoological nomenclature, classification and species delimitation based on morphological and molecular traits as well as on integrative taxonomy.
Learning outcomes	Understanding the theoretical principles underlying systematics, concept of integrative taxonomy, different approaches to delimitate species.

2. Teaching and learning methods

	Type of instruction	Topic	Language of instruction	Group size	Weekly contact time*	Workload [h]
	S	Principles of Taxonomy	en.	20	2	75

3. Prerequisites for the module

compulsory	OEP-M2
recommended	none

4. Degree program allocation

Study program	compulsory/ elective	Semester
MSc OEP-Biology	elective	2 o. 3
BSc Biology	elective	5
ZIGS graduate school	compulsory	

5. Requirements for the award of credits (ECTS)		6. Credits
Required achievements	none	**2.5**
Assessment (incl. weighting) and examination language	Written exam (Klausur) (100%), en.	

7. Frequency				8. Workload	9. Duration
Winter semester	☒	Winter and summer semester	☐	**75h**	**1 sem.**
Summer semester	☒				

Module coordination

Teacher	Dr. D. Ahrens (ZMFK)
Module coordinator	Dr. D. Ahrens (ZMFK)
Institute/Department	Biologie, ZFMK

Further information

(Reading lists, information links etc.)	Recommended Readings Quicke, D. (1993) Principles and techniques of contemporary taxonomy. Blackie Academic and Professional, 311pp. Wheeler, Q.D. (2008) The new Taxonomy. The Systematics Association Special Volume Series 76. CRC Press, 237pp. Wheeler, Q.D. & Meier R. (2000) Species concepts and the phylogenetic theory: a debate. Columbia University Press, New York, 230pp. https://www.iczn.org/the-code/the-international-code-of-zoological-nomenclature/the-code-online/

* SWS

Bioinformatics and Evolutionary Genomics

OEP-A06

UNIVERSITÄT BONN

1. Content and intended learning outcomes

Content	Introduction of evolutionary patterns and processes of molecular sequences and genomic features. Introduction to bioinformatic principles and some widely used databases and tools, like automatic retrieval of simple or bulk data, comparing sequences via alignments and BLAST searches, use of sequence data for population genetics and phylogenetics. Massive datasets from modern sequencing methods: Assembling genomic datasets from short reads and functional annotation of genes. Long-read vs. short-read sequencing. Identifying mutations and selection pressure. How does information content differ in microbial versus eukaryotic genomes, genome browsers. Genomics/Transcriptomics/Proteomics. Gene content, gene expression and systems biology. Evolution of the human genome and inherited diseases. Evolution of viral genomes. Phylogenomics and Population genomics. Basal use of UNIX, bash tools, python and R will be introduced accompanying these topics.
Learning outcomes	Learning to obtain and handle genetic / genomic datasets with bioinformatic approaches. First steps into building own solutions with scripting languages (e.g. python), simple database structures and graphical presentation (R). Critically interpretion of recent publications.

2. Teaching and learning methods

	Type of instruction	Topic	Language of instruction	Group size	Weekly contact time*	Workload [h]
	V	Bioinf. & Evol. Genomics	en.	12	2	60
	P	Bioinf. & Evol. Genomics	en.	12	6	240

3. Prerequisites for the module

compulsory	OEP-M2
recommended	none

4. Degree program allocation

	Study program	compulsory/ elective	Semester
	MSc OEP-Biology	elective	2 o. 3

5. Requirements for the award of credits (ECTS)		6. Credits
Required achievements	none	**10**
Assessment (incl. weighting) and examination language	written report (Protokoll), (50%), en. oral presentation (Präsentation), (50%), en.	

7. Frequency				8. Workload	9. Duration
Winter semester	☒	Winter and summer semester	☐	**300h**	**1 sem.**
Summer semester	☒				

Module coordination

Teacher	PD Dr. L. Podsiadlowski (ZMFK)
Module coordinator	PD Dr. L. Podsiadlowski (ZFMK)
Institute/Department	Biologie, ZFMK

Further information

(Reading lists, information links etc.)	Recommended Readings Samuelsson , Tore „Genomics and Bioinformatics“ Cambridge Univ Press 2012 (this book comes close to the concept of my course) Christianini N, Hahn M “Introduction to computational genomics, Cambridge Univ Press 2007 Haddock SHD, Dunn CW “Practical computing for biologists” 2012 Sinauer (helpful skills for anyone using computers beyond MS Office, Facebook & Youtube) Lesk, Arthur “Bioinformatics” (more general overview of bioinformatic uses)

* SWS

Histology, Tomography, and Computer-aided 3D Reconstruction of Animal Anatomy
OEP-A07

UNIVERSITÄT BONN

1. Content and intended learning outcomes

Content	This course demonstrates how characters of metazoan internal anatomy can be explored for phylogenetic analyses. The main objectives are to understand how tomographic imaging techniques are employed, how histological sections are produced and interpreted, how 3D models of internal organs are generated, how digital data can be publicly archived, and how anatomical studies can contribute to reveal phylogenetic relationships among metazoan taxa. Lectures provide the theoretical background for digital imaging and histological techniques, long-term data deposition, and computer-aided image processing.
Learning outcomes	(1) Interpretation of histological sections and of data derived from non-destructive tomographic imaging techniques. (2) Improved understanding of the evolutionary anatomy of internal organ systems in metazoans. (3) Software application skills in anatomical 3D reconstruction and data deposition.

2. Teaching and learning methods

	Type of instruction	Topic	Language of instruction	Group size	Weekly contact time*	Workload [h]
	V	3D reconstruction of animal anatomy	en.	14	2	60
	P	3D reconstruction of animal anatomy	en.	14	8	240

3. Prerequisites for the module

compulsory	OEP-M1
recommended	Basic computer skills, in particular desktop operations in Windows

4. Degree program allocation

	Study program	compulsory/ elective	Semester
	MSc OEP-Biology	elective	2 o. 3

5. Requirements for the award of credits (ECTS)		6. Credits
Required achievements	none	**10**
Assessment (incl. weighting) and examination language	written report (Protokoll), (34%), en. poster presentation (Poster), (33%), en. oral presentation (Präsentation), (33%), en.	

7. Frequency				8. Workload	9. Duration
Winter semester	☒	Winter and summer semester	☐	**300h**	**1 sem.**
Summer semester	☒				

Module coordination

Teacher	PD Dr. A. Ziegler, Dr. P. Beckers
Module coordinator	PD Dr. A. Ziegler, Dr. P. Beckers
Institute/Department	IEZ, Biologie

Further information

(Reading lists, information links etc.)

1. Ziegler A, et al. (2008) Systematic comparison and reconstruction of sea urchin (Echinoidea) internal anatomy: a novel approach using magnetic resonance imaging. *BMC Biology* 6:33
2. Ruthensteiner B (2008) Soft part 3D visualization by serial sectioning and computer reconstruction. *Zoosymposia* 1:63-100
3. Ziegler A, et al (2010) Opportunities and challenges for digital morphology. *Biology Direct* 5:45
4. Beckers P, et al. (2013) The nervous systems of basally branching Nemertea (Palaeonemertea). *PLoS ONE* 8:e66137
5. Beckers P, et al. (2019) The anatomy and development of the nervous system in Magelonidae (Annelida) – insights into the evolution of the annelid brain. *BMC Evolutionary Biology* 19:173
6. Ziegler A (2019) Combined visualization of echinoderm hard and soft parts using contrast-enhanced micro-computed tomography. *Zoosymposia* 15:172-191

* SWS

Phenotypisation and cladistic analysis of morphological characters
OEP-A08

UNIVERSITÄT BONN

1. Content and intended learning outcomes

Content	The course is composed of two parts. During the first part students will learn how to quantify and analyse shape variation in biology using geometric morphometrics (= phenotyping). Various zoological samples will be studied. Phenotyping is an important concept in research (e.g. organismic variation in relation to climate change; Phenotypic macro- and microevolution), medical development (e.g. plastic surgery), and industry (e.g. crop science). The second part introduces into pertinent software for Maximum Parsimony analyses and improves understanding of its applications. Published character matrices are provided to test for reproducibility, robustness and sensitivity under various weighting regimes, to infer implications of alternative topologies (e.g., by mapping on molecular trees), and to evaluate the explanatory strength of a given data set. The results of the exercises are summarized by the students at the end of each session in oral presentations.
Learning outcomes	Conceptualization, sample dissection, imaging, shape analysis,

2. Teaching and learning methods

	Type of instruction	Topic	Language	Group size	Weekly contact time*	Workload [h]
	V	Morphometrics and morphological character analysis	en.	16	1	60
	P	Morphometrics and morphological character analysis	en.	16	4	240

3. Prerequisites for the module

compulsory	OEP-M1, OEP-M2
recommended	none

4. Degree program allocation

	Study program	compulsory/ elective	Semester
	MSc OEP-Biology	elective	2 o. 3

5. Requirements for the award of credits (ECTS)		6. Credits
Required achievements	oral presentation (Präsentation), en. scientific exposé (data sheet), en.	**10**
Assessment (incl. weighting) and examination language	written exam (Klausur), (100%) en.	

7. Frequency		8. Workload	9. Duration
Winter semester ☐ Summer semester ☒	Winter- and summer semester ☐	**300 h**	**1 Sem.**

Module coordination

Teacher	Dr. M. Koch, Prof. A. Blanke
Module coordinator	Dr. M. Koch, Prof. A. Blanke
Institute/Department	IEZ, Biologie

Further information

(Reading lists, information links etc.)	Zelditch M.L., Swiderski D.L., Sheets H.D., Fink W.L. 2004. Geometric Morphometrics for Biologists: A Primer. Elsevier. Wägele JW (2005) Foundations of Phylogenetic Systematics. Verlag Dr. Friedrich Pfeil.

* SWS

Application of Immunohistochemistry in Invertebrate Systematics
OEP-A09

UNIVERSITÄT BONN

1. Content and intended learning outcomes

Content	This course provides an introduction to techniques for studying the early development of muscular and nervous systems in invertebrates by confocal Laserscanning Microscopy (cLSM). Project-based lab work includes fixation techniques and processing of fixed tissues for antibody-staining and fluorescent dyes, followed by cLS-Microscopy. The lecture provides theoretical background on the techniques, on data processing into 3D-representations, and on the use of developmental data in phylogenetic systematics. Main objectives are to learn how immuno- and fluorescent stainings are interpreted, which kind of information on organogenesis can be obtained from such studies, and how data on organogenesis contribute to phylogenetic questions.
Learning outcomes	Theory and practice of fluorescent immunohistochemical staining techniques, in-depth understanding of evolutionary anatomy of early developmental stages in invertebrates

2. Teaching and learning methods

	Type of instruction	Topic	Language of instruction	Group size	Weekly contact time*	Workload [h]
	V	Immunohistochem.	en.	8	1	30
	P	Immunohistochem.	en.	8	4	120

3. Prerequisites for the module

compulsory	OEP-M1
recommended	none

4. Degree program allocation

	Study program	compulsory/ elective	Semester
	MSc OEP-Biology	elective	2 o. 3

5. Requirements for the award of credits (ECTS)		6. Credits
Required achievements	oral presentation (Präsentation), en. written report (Protokoll), en.	**5**
Assessment (incl. weighting) and examination language	written exam (Klausur) (100%), en.	

7. Frequency				8. Workload	9. Duration
Winter semester	☒	Winter and summer semester	☐	**150h**	**1 sem.**
Summer semester	☒				

Module coordination

Teacher	Dr. J. von Döhren
Module coordinator	Prof. Dr. T. Bartolomaeus
Institute/Department	IEZ, Biologie

Further information

(Reading lists, information links etc.)	Recommended Readings Schmidt-Rhaesa A (2007) The Evolution of Organ Systems, Oxford University Press

* SWS

Application of Electron Microscopy in Invertebrate Systematics **OEP-A10**	UNIVERSITÄT BONN

1. Content and intended learning outcomes	
Content	Organs of developmental and larval stages are often regarded as highly conserved within animal evolution. Therefore, their morphology and development exert an important influence on phylogenetic hypotheses regarding high-ranking taxa like the Spiralia. On the other hand, structural features of larvae and developmental stages can often only be elucidated by ultrastructural investigations. The course provides an introduction into electron microscopical techniques, focusing on transmission electron microscopy (TEM) and including tissue preparation and ultrathin sectioning methods. Additionally, students will learn to interpret electron microscopical data and will gain insights into the ultrastructure of larval organ systems.
Learning outcomes	Theory and practice of electron microscopical techniques, ability to interpret electron micrographs, in-depth understanding of evolutionary anatomy of early developmental stages in invertebrates

2. Teaching and learning methods

	Type of instruction	Topic	Language of instruction	Group size	Weekly contact time*	Workload [h]
	S	Electron Microscopy in Invert. System.	en.	8	1	30
	P	Electron Microscopy in Invert. System.	en.	8	4	120

3. Prerequisites for the module	
compulsory	OEP-M1, OEP-M2
recommended	none

4. Degree program allocation

	Study program	compulsory/ elective	Semester
	MSc OEP-Biology	elective	2 o. 3

5. Requirements for the award of credits (ECTS)		**6. Credits**
Required achievements	oral presentation (Präsentation), en.	**5**
Assessment (incl. weighting) and examination language	written report (Protokoll), en.	

7. Frequency				**8. Workload**	**9. Duration**
Winter semester	☐	Winter and summer semester	☐	**150h**	**1 sem.**
Summer semester	☒				

Module coordination	
Teacher	Prof. Dr. T. Bartolomaeus, Dr. J. von Döhren
Module coordinator	Prof. Dr. T. Bartolomaeus
Institute/Department	IEZ, Biology

Further information	
(Reading lists, information links etc.)	Additional information: This module alternates with OEP-A11 and thus is offered every second year Recommended Readings Schmidt-Rhaesa A (2007) The Evolution of Organ Systems, Oxford University Press

* SWS

Practical Course on Electron Microscopy

OEP-A11

UNIVERSITÄT BONN

1. Content and intended learning outcomes

Content	The course will be focusing on practical approaches in electron microscopy. Students will investigate cells and tissues as well as surface structures with the aid of transmission electron microscopy (TEM) and scanning electron microscopy (SEM). Participants will work in groups on a short research project. They will conduct the sample preparation, data generation and interpretations on these projects. This will enable them to compare the ultrastructure of different tissues and structures through several invertebrate taxa. Students will document their results as micrographs and scientific illustrations/reconstructions.
Learning outcomes	Theory and practice of electron microscopical techniques, ability to interpret electron micrographs, electron microscopy as analytical tool, in-depth understanding of ultrastructure and invertebrate anatomy, written and oral presentation of scientific data.

2. Teaching and learning methods

	Type of instruction	Topic	Language of instruction	Group size	Weekly contact time*	Workload [h]
	S	Electron Microscopy	en.	8	1	30
	P	Electron Microscopy	en.	8	4	120

3. Prerequisites for the module

compulsory	OEP-M1
recommended	none

4. Degree program allocation

	Study program	compulsory/ elective	Semester
	MSc OEP-Biology	elective	2 o. 3

5. Requirements for the award of credits (ECTS)		6. Credits
Required achievements	oral presentation (Präsentation), en.	**5**
Assessment (incl. weighting) and examination language	written report (Protokoll), en.	

7. Frequency				8. Workload	9. Duration
Winter semester	☒	Winter and summer semester	☐	**150h**	**1 sem.**
Summer semester	☒				

Module coordination

Teacher	Prof. Dr. T. Bartolomaeus, Dr. E. Tiliç, Dr. M. Koch
Module coordinator	Prof. Dr. T. Bartolomaeus
Institute/Department	IEZ, Biologie

Further information

(Reading lists, information links etc.)	Additional information: This module alternates with OEP-A10 and thus is offered every second year Recommended Readings Schmidt-Rhaesa A (2007) The Evolution of Organ Systems, Oxford University Press

* SWS

DNA Barcoding: Identifying and Describing Biodiversity

OEP-A12

UNIVERSITÄT BONN

1. Content and intended learning outcomes

Content	This module will give an overview into different species concepts, and the use of modern molecular tools for identifying and describing animal species. Examples from current literature will be discussed and presented. The students will learn how to use online DNA databases and how to generate their own DNA sequence data in the lab. Sequences will be analysed by the students using different species delimitation methods and phylogenetic tools. Furthermore, distribution and geographic range of species will be explored using haplotype networks and phylogeographic approaches. The students will analyze a dataset of their own to gain hands-on experience in DNA-Barcoding.
Learning outcomes	Basic skills in the molecular lab, use of phylogenetic software and other computer analysis tools, written and oral presentation of scientific data.

2. Teaching and learning methods

	Type of instruction	Topic	Language of instruction	Group size	Weekly contact time*	Workload [h]
	V	DNA barcoding	en.	12	1	30
	P	DNA barcoding	en.	12	4	120

3. Prerequisites for the module

compulsory	OEP-M1
recommended	none

4. Degree program allocation

	Study program	compulsory/ elective	Semester
	MSc OEP-Biology	elective	2 o. 3

5. Requirements for the award of credits (ECTS)		6. Credits
Required achievements	oral presentation (Präsentation), en.	**5**
Assessment (incl. weighting) and examination language	written report (Protokoll) (100%), en.	

7. Frequency				8. Workload	9. Duration
Winter semester	☒	Winter and summer semester	☐	**150h**	**1 sem.**
Summer semester	☒				

Module coordination

Teacher	Dr. E. Tiliç
Module coordinator	Prof. Dr. T. Bartolomaeus
Institute/Department	IEZ, Biologie

Further information

(Reading lists, information links etc.)	Recommended Readings Moritz C, Cicero C (2004) DNA Barcoding: Promise and Pitfalls. PLoS Biol 2(10): e354. https://doi.org/10.1371/journal.pbio.0020354

* SWS

Strukturelle u. materialwissenschaftliche Charakterisierung biologischer Materialien u. Rezeptoren OEP-A13	UNIVERSITÄT BONN

1. Content and intended learning outcomes	
Content	In the module, the students will acquire advanced knowledge in material properties of different biological materials. In particular students will learn how to prepare and arrange samples for investigations with up-to-date techniques used in biomaterials research and will do experiments with an atomic force microscope (AFM) and a Hysitron nanoindenter. An important aspect of this course is to teach the students to develop own ideas and hypotheses and to design appropriate experimental protocols to test these hypotheses. In addition, students will learn how to present and discuss own scientific data.
Learning outcomes	Basic knowledge in material properties of biological materials including important up-to-date investigation methods

2. Teaching and learning methods						
	Type of instruction	Topic	Language of instruction	Group size	Weekly contact time*	Workload [h]
	P	Biol. Materialien & Rezeptoren	de.	4	8	300

3. Prerequisites for the module	
compulsory	OEP-M1, OEP-M2
recommended	none

4. Degree program allocation			
	Study program	compulsory/ elective	Semester
	MSc OEP-Biology	elective	2 o. 3

5. Requirements for the award of credits (ECTS)		**6. Credits**
Required achievements	none	**10**
Assessment (incl. weighting) and examination language	oral presentation (Präsentation), (50%), de. scientific exposé (*data sheet*), (10%), de. written report (Protokoll), (40%), de. .	

7. Frequency				**8. Workload**	**9. Duration**
Winter semester	☒	Winter and summer semester	☐	**300h**	**1 sem.**
Summer semester	☒				

Module coordination	
Teacher	PD Dr. H. Schmitz, PD Dr. A. Schmitz
Module coordinator	PD Dr. H. Schmitz
Institute/Department	IZ, Biologie

Further information	
(Reading lists, information links etc.)	Additional information: Teaching language is German Recommended Readings Oliver WC, Pharr GM (1992) An improved technique for determining hardness and elastic modulus using load and displacement sensing indentation experiments. Journal of Materials Research 7, 1564-1583.

* SWS

Plant Molecular Evolution and Phylogeny

OEP-A14/PMEP

UNIVERSITÄT BONN

1. Content and intended learning outcomes

Content	Molecular data offer a plethora of information to reconstruct the phylogeny of life on earth. After a brief introduction into the basics of molecular biology (genomes, gene structures, exons, introns, genetic codes, nucleotide and protein sequences) as well as cladistics and systematics the lecture will mainly deal with the methods of phylogenetic analyses: Homologies, data base searches, alignments and the concepts of phylogenetic tree construction (distance, parsimony and likelihood methods). Students will be strongly encouraged to gain hands-on experience using WWW accessible resources and freely available software such as MEGA etc.
Learning outcomes	Evolutionary-based understanding of modern phylogenetics, taxonomy and cladistics, use of databases and database query searching, understanding concepts and algorith of phylogenetic software tools for data assembly, alignments and construction of phylogenetic trees.

2. Teaching and learning methods

	Type of instruction	Topic	Language of instruction	Group size	Weekly contact time*	Workload [h]
	V	Plant Mol. Evol. Phyl.	en.	40	2	120
	S	Plant Mol. Evol. Phyl.	en	15	1	30

3. Prerequisites for the module

compulsory	OEP-M1, OEP-M2
recommended	none

4. Degree program allocation

	Study program	compulsory/ elective	Semester
	MSc OEP-Biology	elective	2 o. 3
	MSc Plant Sciences	elective	2 o. 3

5. Requirements for the award of credits (ECTS)		6. Credits
Required achievements	Oral presentation (Präsentation)	5
Assessment (incl. weighting) and examination language	written exam (Klausur) (60%), en. Oral presentation (Referat) (40%), en.	

7. Frequency				8. Workload	9. Duration
Winter semester	☒	Winter and summer semester	☐	**150h**	**1 sem.**
Summer semester	☒				

Module coordination

Teacher	Prof. Dr. Volker Knoop
Module coordinator	Prof. Dr. Volker Knoop
Institute/Department	IZMB, Biology

Further information

(Reading lists, information links etc.)	Recommended Reading Knoop V & Müller K (2009) Gene und Stammbäume Elsevier Spektrum, Heidelberg, 2nd edition. Hall B (2012) Phylogenetic trees made easy. Sinauer Assoc., Sunderland, MA (currently 4th ed.)

* SWS

Geographic Information Systems (GIS) for Plant Biogeography and Conservation
OEP-A15/PBCO1

UNIVERSITÄT BONN

1. Content and intended learning outcomes

Content	Understanding the spatial distribution of biodiversity is crucial for its further exploration, use, and conservation. This module combines an introduction in mapping and spatial data analysis using GIS with theory and excercises from the fields of macroecology and biogeography. A special focus will be conservation biogeography including priority setting and analyses of the impact of global environmental change on biodiversity. By the end of the module, students should be able to design and perform analyses in the fields of macroecology, biogeography, and nature conservation using GIS and spatial data analyses
Learning outcomes	The use of Geographic Information Systems (GIS) for mapping and spatial analyses; skills for planning, performing, documentation, and presentation of scientific analyses.

2. Teaching and learning methods

	Type of instruction	Topic	Language of instruction	Group size	Weekly contact time*	Workload [h]
	P	GIS for Plant Biogeography and Conservation	en.	6+6	4	150

3. Prerequisites for the module

compulsory	OEP-M1, OEP-M2
recommended	none

4. Degree program allocation

Study program	compulsory/ elective	Semester
MSc OEP-Biology	elective	3
MSc Plant Sciences	elective	1 o. 3

5. Requirements for the award of credits (ECTS) / 6. Credits

Required achievements	none	**5**
Assessment (incl. weighting) and examination language	oral presentation (Präsentation), 60%, en. written reports (Protokolle), 40%, en.	

7. Frequency				8. Workload	9. Duration
Winter semester	☒	Winter and summer semester	☐	**150h**	**1 sem.**
Summer semester	☐				

Module coordination

Teacher	Dr. J. Mutke, Prof. Dr. M. Weigend, scientists of the NEES Institute
Module coordinator	Dr. J. Mutke
Institute/Department	NEES, Biologie

Further information

(Reading lists, information links etc.)	Recommended Reading LOMOLINO, RIDDLE, WHITTAKER & BROWN. Biogeography, Sinauer. MILLINGTON, BLUMLER & SCHICKHOFF (eds.). Handbook of Biogeography. Sage Publications: London PRIMACK: Essentials of Conservation Biology.Sinauer. WEGMANN et al.: Remote Sensing and GIS for Ecologists. Pelagic Publishing.

* SWS

Biodiversity Informatics: Data Analyses for Ecology and Biogeography **OEP-A16/PBCO2**	UNIVERSITÄT BONN

1. Content and intended learning outcomes	
Content	This course provides an overview of methods commonly used to analyse and model data in the field of ecology (incl. macroecology) and biogeography. This includes analyses and modelling of spatial data in a geographic context (e.g. bioclimatic modelling / environmental niche models) – thus some background in the context of geographic information systems is of advantage. By the end of the module, students should be able to design and perform analyses in the fields of (macro-) ecology and biogeography using mainly code based analysis software such as R or Julia.
Learning outcomes	Code based data analysis, skills for planning, performing, documentation, and presentation of scientific analyses.

2. Teaching and learning methods						
	Type of instruction	Topic	Language of instruction	Group size	Weekly contact time*	Workload [h]
	P		en.	6+6	4	150

3. Prerequisites for the module	
compulsory	OEP-M1, OEP-M2
recommended	none

4. Degree program allocation			
	Study program	compulsory/ elective	Semester
	MSc OEP-Biology	elective	3
	MSc Plant Sciences	elective	1 o. 3

5. Requirements for the award of credits (ECTS)		**6. Credits**
Required achievements	none	**5**
Assessment (incl. weighting) and examination language	oral presentation (Präsentation), 60%, en. written report (Protokoll), 40%, en.	

7. Frequency				**8. Workload**	**9. Duration**
Winter semester	☒	Winter and summer semester	☐	**150h**	**1 sem.**
Summer semester	☐				

Module coordination	
Teacher	Dr. J. Mutke, Prof. Dr. M. Weigend, scientists of the NEES Institute
Module coordinator	Dr. J. Mutke
Institute/Department	NEES, Biology

Further information	
(Reading lists, information links etc.)	Recommended Reading GUISAN et al.: Habitat Suitability and Distribution Models. Cambridge. S. QIAN: Environmental and Ecological Statistics with R, Second Edition.. CRC. WEGMANN et al.: Remote Sensing and GIS for Ecologists. Pelagic Publishing.

* SWS

Transport Physiology

OEP-A17/TPP

UNIVERSITÄT BONN

1. Content and intended learning outcomes

Content	In the lab course relevant examples of plant environment interactions from the molecular to the organismic level will be studied. Experiments will deal with water and salt stress, effects of xenobiotics on plants, plant microorganism interaction and secondary plant metabolites. Experimental approaches include measurement of chlorophyll fluorescence, porometry, measurement of cuticular transpiration and uptake of xenobiotics in leaves and analysis of gene expression in response to environmental stimuli. Experiments will be conducted with model and crop species.
Learning outcomes	The practical course will provide insights into modern techniques used in molecular plant physiology and ecology. The students should learn different methods in transport physiology and gain experience in planning and performing experiments independently.Laboratory techniques in modern plant research. Skills for designing experiments, critical data evaluation, documentation and presentation of scientific results.

2. Teaching and learning methods

	Type of instruction	Topic	Language of instruction	Group size	Weekly contact time*	Workload [h]
	P	Transport Physiology	en.	10	8	300

3. Prerequisites for the module

compulsory	OEP-B11/PBPM0, OEP-M2
recommended	none

4. Degree program allocation

	Study program	compulsory/ elective	Semester
	MSc OEP-Biology	elective	2
	MSc Plant Sciences	elective	2 o. 3

5. Requirements for the award of credits (ECTS)		6. Credits
Required achievements	oral presentation (Präsentation)	**10**
Assessment (incl. weighting) and examination language	written exam (Klausur) (100%), en.	

7. Frequency				8. Workload	9. Duration
Winter semester	☐	Winter and summer semester	☐	**300h**	**1 sem.**
Summer semester	☒				

Module coordination

Teacher	Prof. Dr. L. Schreiber
Module coordinator	Prof. Dr. L. Schreiber
Institute/Department	IZMB, Biologie

Further information

(Reading lists, information links etc.)	Recommended Reading Taiz L, Zeiger E (2006) Plant Physiology. Sinauer Associates Inc., Sunderland, MA, Schulze ED, Beck E, and Müller-Hohenstein K. Plant Ecology, Heidelberg: Springer, 2005

* SWS

Modern Biodiversity Research: from Population Genetics to Phylogenomics **OEP-A18/MBRE**	UNIVERSITÄT BONN

1. Content and intended learning outcomes	
Content	Our understanding of plant relationships and evolution has been revolutionized by the first angiosperm phylogeny in 1993, and the field is still developing at great pace. Thus major emphasis in the modul is put on providing an introduction to the rapidly developing methods in the field, both in the laboratory and at the computer. Sources of information treated range from Sanger sequences to single molecule real time sequencing and beyond. Case studies deal with important groups such as angiosperms, ferns and bryophytes in greater detail.
Learning outcomes	Participants gain a fundamental understanding of molecular evolutionary processes governing the change of DNA, and application of this information to phylogenetic and evolutionary analysis. They develop skills in generating molecular data (wet lab) and using computers (dry lab) for contig assembly based on pherograms (Sanger sequencing), genome assembly and annotation based on NGS and fourth generation data, alignment, phylogenetic reconstructions as well as population genetics and basics in writing and applying scripts for example in Unix, R and Python.

2. Teaching and learning methods						
	Type of instruction	Topic	Language of instruction	Group size	Weekly contact time*	Workload [h]
	P	Modern Biodiversity Research	en.	8	8	300

3. Prerequisites for the module	
compulsory	OEP-M1, OEP-M2
recommended	none

4. Degree program allocation			
	Study program	compulsory/ elective	Semester
	MSc OEP-Biology	elective	3
	MSc Plant Sciences	elective	3

5. Requirements for the award of credits (ECTS)		**6. Credits**
Required achievements	none	**10**
Assessment (incl. weighting) and examination language	oral presentation (Präsentation), 30%, en. written report (Protokoll), 70%, en.	

7. Frequency				**8. Workload**	**9. Duration**
Winter semester	☒	Winter and summer semester	☐	**300h**	**1 sem.**
Summer semester	☐				

Module coordination	
Teacher	Prof. Dr. D. Quandt, scientists of the NEES Institute
Module coordinator	Prof. Dr. D. Quandt
Institute/Department	NEES, Biologie

Further information	
(Reading lists, information links etc.)	Recommended Reading D. Hillis, C. Moritz and B. Mable (1996). Molecular Systematics (2nd ed.). Sinauer. D. Soltis, P. Soltis and J Doyle (1998). Molecular Systematics of Plants II (DNA Sequencing). Kluwer. Volker Knoop and Kai Müller. Gene und Stammbäume, Heidelberg, München: Elsevier Spektrum. K. Weising et al. DNA Fingerprinting in Plants: Principles, Methods, and Applications. CRC Press. R. Page & E. Holmes. Molecular Evolution - A Phylogenetic Approach. Blackwell.

* SWS

Plant Evolution and Phylogenetics Lab

OEP-A19/PEPL

UNIVERSITÄT BONN

1. Content and intended learning outcomes

Content	The lab course will deal with the phylogenetic information stored in the genomes of living plants over 500 million years of land plant evolution. Molecular techniques, mainly DNA and RNA extraction, cDNA synthesis, PCR amplification, cloning and sequencing and computer programs for database analyses and molecular phylogenetic constructions will be used to retrieve this information. Taxonomic focus will be put on different land plant (and possibly also on certain algal and protist) clades depending on currently interesting topics and up-to-date research in the group. With respect to genetic loci analyzed, a focus will be the mitochondrial and chloroplast genomes of plants with their peculiar features and mechanisms of gene expression such as Horizontal Gene Transfer, RNA editing and cis- and trans-splicing introns.
Learning outcomes	Students obtain a good understanding of land plant evolution from a molecular genetic and genomic point of view. They should be able to answer questions on standard molecular biological cloning techniques and bioinformatic sequence analyses as well as on the diversity of land plant clades and different approaches taken in molecular phylogenetic analyses. Participation in the module PMEP is strongly advised for a deeper and more integrated understanding.

2. Teaching and learning methods

	Type of instruction	Topic	Language of instruction	Group size	Weekly contact time*	Workload [h]
	P	Plant Evol. and Phylogeny	en.	12	8	300

3. Prerequisites for the module

compulsory	OEP-M1, OEP-M2
recommended	none

4. Degree program allocation

	Study program	compulsory/ elective	Semester
	MSc OEP-Biology	elective	2
	MSc Plant Sciences	elective	2

5. Requirements for the award of credits (ECTS)		6. Credits
Required achievements	oral presentation (Präsentation), Participation in practical experiments	**10**
Assessment (incl. weighting) and examination language	written exam (Klausur) (50%), en. oral presentation (Referat) (50%), en.	

7. Frequency				8. Workload	9. Duration
Winter semester	☒	Winter and summer semester	☐	**300h**	**1 sem.**
Summer semester	☒				

Module coordination

Teacher	Prof. Dr. V. Knoop
Module coordinator	Prof. Dr. V. Knoop
Institute/Department	IZMB, Biologie

Further information

(Reading lists, information links etc.)	Recommended Reading D Volker Knoop (2013) Plant mitochondrial genome peculiarities evolving in the earliest vascular plant lineages. *Journal of Systematics and Evolution* 51(1):1-12 Bock R & Knoop V (eds) (2012) Genomics of Chloroplasts and Mitochondria, Vol 35 in the series "Advances in Photosynthesis and Respiration". Springer, Dordrecht. Knoop V & Müller K (2009) Gene und Stammbäume Elsevier Spektrum, Heidelberg, 2nd ed. Hall B (2012) Phylogenetic trees made easy. Sinauer Assoc., Sunderland, MA (currently 4th ed.)

* SWS

Chemistry of Natural Products

OEP-A20

UNIVERSITÄT BONN

1. Content and intended learning outcomes

Content	The module deals with the analysis and biosynthesis of natural products. The students will learn several techniques to isolate and characterize secondary metabolites, e.g. chromatographic methods (thin layer chromatography, high performance liquid chromatography, gas chromatography) and spectrophotometric methods (UV spectroscopy, nuclear magnetic resonance spectroscopy). A second part of the course mediates knowledge about methods to analyze and identify enzymes, proteins, and biosynthetic genes (electrophoresis, PCR).
Learning outcomes	Knowledge and application of analytical methods of molecules

2. Teaching and learning methods

	Type of instruction	Topic	Language of instruction	Group size	Weekly contact time*	Workload [h]
	S	Drugs from Plants and Microorganisms	en.	12	2	90
	P	Chem. of Natural Products	en.	12	6	210

3. Prerequisites for the module

compulsory	OEP-M1, OEP-M2
recommended	none

4. Degree program allocation

	Study program	compulsory/ elective	Semester
	MSc OEP-Biology	elective	2 o. 3

5. Requirements for the award of credits (ECTS)		6. Credits
Required achievements	oral presentation (Präsentation)	**10**
Assessment (incl. weighting) and examination language	written exam (Klausur) (100%), en.	

7. Frequency				8. Workload	9. Duration
Winter semester	☒	Winter and summer semester	☐	**300h**	**1 sem.**
Summer semester	☒				

Module coordination

Teacher	Prof. Dr. G. König. Dr. S. Kehraus
Module coordinator	Prof. Dr. G. König
Institute/Department	Pharmazie

Further information

(Reading lists, information links etc.)	Recommended Reading Paul M. Dewick, Medicinal Natural Products, Wiley, 2001 Richard J.P. Cannell, Natural Products Isolation, Humana Press, 1998 Terence A. Brown, Gene Cloning and DNA Analysis, Blackwell Publishing, 2006

* SWS

Advanced Methods in Organismic Biology, Evolutionary Biology or Paleobiology
OEP-A21

UNIVERSITÄT BONN

1. Content and intended learning outcomes

Content	The module teaches experimental skills to analyse biodiversity and evolution, functional constraints, evolutionary adaptations or structural details of surviving and extinct animals and plants. The aim of the module is methodological competence. The module is a laboratory course.
Learning outcomes	Special lab and methodological competence for analyzing biodiversity and structural components of extant and extinct animals and plants. Application of cutting edge methods to answer questions concerning biodiversity and evolution of extant and extinct fauna and flora

2. Teaching and learning methods

	Type of instruction	Topic	Language of instruction	Group size	Weekly contact time*	Workload [h]
	P, E	as specified	en.	as specified	8	300

3. Prerequisites for the module

compulsory	OEP-M1, OEP-M2
recommended	none

4. Degree program allocation

	Study program	compulsory/ elective	Semester
	MSc OEP-Biology	elective	2 o. 3

5. Requirements for the award of credits (ECTS) / 6. Credits

Required achievements	none	**10**
Assessment (incl. weighting) and examination language	written report (Protokoll) (100%), en.	

7. Frequency				8. Workload	9. Duration
Winter semester	☒	Winter and summer semester	☐	**300h**	**1 sem.**
Summer semester	☒				

Module coordination

Teacher	All teachers of the OEP-Biology program
Module coordinator	Prof. Dr. T. Bartolomaeus
Institute/Department	Biologie, ZKMK

Further information

(Reading lists, information links etc.)	Additional information The module is a laboratory course and is individually arranged. Additional information is provided upon admission to the module.

* SWS

Advanced Computer Skills in Organismic Biology, Evolutionary Biology or Paleobiology **OEP-A22**	UNIVERSITÄT BONN

1. Content and intended learning outcomes	
Content	The module deals with specific topics of the application of (bio)computer science for the visualization of structures as well as for modeling evolutionary processes and the relationships between structure and function.
Learning outcomes	Specific computer sciences skills for visualization of structures and modelling functional constraints. Application of cutting edge methods to answer questions concerning biodiversity and evolution of extant and extinct fauna and flora.

2. Teaching and learning methods						
	Type of instruction	Topic	Language of instruction	Group size	Weekly contact time*	Workload [h]
	P	as specified	en.	as specified	8	300

3. Prerequisites for the module	
compulsory	OEP-M1, OEP-M2
recommended	none

4. Degree program allocation			
	Study program	compulsory/ elective	Semester
	MSc OEP-Biology	elective	3

5. Requirements for the award of credits (ECTS)		**6. Credits**
Required achievements	none	**10**
Assessment (incl. weighting) and examination language	written report (Protokoll) (100%), en.	

7. Frequency				**8. Workload**	**9. Duration**
Winter semester	☒	Winter and summer semester	☐	**300h**	**1 sem.**
Summer semester	☐				

Module coordination	
Teacher	Teachers of the OEP-Biology program
Module coordinator	Prof. Dr. T. Bartolomaeus
Institute/Department	Biologie, ZFMK

Further information	
(Reading lists, information links etc.)	Additional information The module is a laboratory course and is individually arranged. Additional information is provided upon admission to the module.

* SWS

Advanced Bioinformatics in Organismic Biology, Evolutionary Biology or Paleobiology Research
OEP-A23

UNIVERSITÄT BONN

1. Content and intended learning outcomes

Content	The module covers specific topics of the application of (bio)computer science for the analysis of evolution, phylogenetics, biogeography and biodiversity monitoring.
Learning outcomes	The module teaches of special skills in using computer science for analysing phylogenies and biogeography and for monitoring biodiversity. Advanced skills in bioinformatics, ability to develop computer scripts

2. Teaching and learning methods

	Type of instruction	Topic	Language of instruction	Group size	Weekly contact time*	Workload [h]
	P	as specified	en.	as specified	8	300

3. Prerequisites for the module

compulsory	OEP-M1, OEP-M2
recommended	none

4. Degree program allocation

	Study program	compulsory/ elective	Semester
	MSc OEP-Biology	elective	3

5. Requirements for the award of credits (ECTS) / 6. Credits

Required achievements	none	**10**
Assessment (incl. weighting) and examination language	written report (Protokoll) (100%), en.	

7. Frequency				8. Workload	9. Duration
Winter semester	☒	Winter and summer semester	☐	**300h**	**1 sem.**
Summer semester	☐				

Module coordination

Teacher	Teachers of the OEP-Biology program
Module coordinator	PD Dr. Lars Podsiadlowski
Institute/Department	Biologie, ZFMK

Further information

(Reading lists, information links etc.)	Additional information The module is a laboratory course and is individually arranged. Additional information is provided upon admission to the module.

* SWS

Experimental design and statistics with R

OEP-A24

UNIVERSITÄT BONN

1. Content and intended learning outcomes

Content	The course will introduce students to the open-source statistics program "R" and provide an overview of experimental design and statistical data analysis from the basics to high-level methods. Covered topics include: (i) experimental design for observational and experimental studies (ii) estimation of variability and central tendency; (iii) probability distributions, hypothesis testing (iv) linear statistical models; (v) generalized linear models; (vi) mixed-effects models and (vii) advanced methods
Learning outcomes	The students are able to plan and design an own study and analyse their data following principles of good statistical practice.

2. Teaching and learning methods

	Type of instruction	Topic	Language of instruction	Group size	Weekly contact time	Workload [h]
	V	Experimental design and statistics with R	en	40	1	60
	P	Experimental design and statistics with R	en	40	2	90

3. Prerequisites for the module

compulsory	None
recommended	None

4. Degree program allocation

	Study program	compulsory/ elective	Semester
	MSc OEP-Biology	Elective	2 o. 3

5. Requirements for the award of credits (ECTS)		6. Credits
Required achievements	none	5
Assessment (incl. weighting) and examination language	Written report (Protokoll), (100%), en.	

7. Frequency				8. Workload	9. Duration
Winter semester	☒	Winter and summer semester	☐	**150h**	**1 sem.**
Summer semester	☒				

Module coordination

Teacher	Prof. Dr. Christoph Scherber
Module coordinator	
Institute/Department	Zoological Research Museum Aexander Koenig, Centre for Biodiversity Monitoring

Further information

(Reading lists, information links etc.)	

Elective modules

Elective area B

Modules with less than 50% fieldwork

Environment and Behaviour: Theory

OEP-B01 INAKTIV

UNIVERSITÄT BONN

1. Content and intended learning outcomes

Content	This module gives the students a first grasp of the concepts of the different disciplines of the behavioural sciences, ranging from Classical Ethology to Behavioural Ecology and Evolutionary Psychology. The module will aim to develop students' understanding of the complexity and diversity of animal behaviour, which has developed during evolution as an adaptation to biotic and abiotic environmental conditions. Students will learn that it can be studied from either a proximate or an ultimate approach, which together will lead to a full understanding of why animals behave in a certain way in a given situation. Students will understand that in order to study animal behaviour in all its aspects, scientists have to develop scientific hypothesis, which then are proved or disapproved experimentally.
Learning outcomes	The module teaches concepts and methods in all fields of behavioural sciences, like classical Ethology, Sociobiology, Behavioural Physiology, and Neuroethology. Behavioural sciences is introduced as hypothesis driven science that is either studied from a proximate or an ultimate approach.

2. Teaching and learning methods

	Type of instruction	Topic	Language of instruction	Group size	Weekly contact time*	Workload [h]
	S	Sensory Ecology	en.	20	2	75
	S	Special Topics in Animal Behaviour	en.	20	2	75

3. Prerequisites for the module

compulsory	OEP-M2
recommended	none

4. Degree program allocation

	Study program	compulsory/ elective	Semester
	MSc OEP-Biology	elective	2 o. 3

5. Requirements for the award of credits (ECTS)		6. Credits
Required achievements	None	**5**
Assessment (incl. weighting) and examination language	Oral presentation (Referat) (50%), en. Oral presentation (Referat) (50%), en.	

7. Frequency				8. Workload	9. Duration
Winter semester	☒	Winter and summer semester	☐	**150h**	**1 sem.**
Summer semester	☒				

Module coordination

Teacher	Prof. Dr. G. von der Emde, Dr. I. P. Rick
Module coordinator	Prof. Dr. G. von der Emde
Institute/Department	IZ/Biologie

Further information

(Reading lists, information links etc.)	Alcock, J. (2005) Animal Behavior: an evolutionary approach Zupanc, G.K.H. (2003) Behavioral Neurobiology, An integrative approach.

* SWS

Environment and Behaviour: Practical Cognition and Behaviour OEP-B02	UNIVERSITÄT BONN

1. Content and intended learning outcomes	
Content	This module gives the students a first grasp of the concepts and experimental techniques of the different disciplines of the behavioural sciences. These include among others classical Ethology, Sociobiology, Behavioural Physiology, and Neuroethology. The practical course will be conducted in groups of 2-3 students, and students will perform experiments 6 hours per day using different animal models and set-ups. At the end of the course, each group will present their results to all their fellow students in the format of a scientific talk. Each student will give an oral presentation in a seminar series held at some stage during the four week course. The topics discussed will cover recent publications in the behavioural/cognitive sciences.
Learning outcomes	The students will acquire basic knowledge about the different disciplines of behavioural sciences. The module will aim to develop students understanding of the complexity and diversity of animal behaviour, which has developed during evolution as an adaptation to biotic and abiotic environmental conditions. Students gain an understanding of this approach by developing their own hypothesis about certain aspects of animal behaviour and subsequently testing their hypothesis through behavioural experiments. For data analysis students will learn to use different analysis methods and statistical tests. Students will learn about the process of producing scientific publications by writing experimental protocols and by giving presentations of their results to their fellow students.

2. Teaching and learning methods						
	Type of instruction	Topic	Language of instruction	Group size	Weekly contact time*	Workload [h]
	P	Cogn. and Behaviour	en.	12	8	300

3. Prerequisites for the module	
compulsory	OEP-M2
recommended	none

4. Degree program allocation			
	Study program	compulsory/ elective	Semester
	MSc OEP-Biology	elective	2 o. 3

5. Requirements for the award of credits (ECTS)		**6. Credits**
Required achievements	Participation in practical experiments	**10**
Assessment (incl. weighting) and examination language	Oral presentation (Präsentation) (50%), en. Written report (Protokoll) (50%), en.	

7. Frequency				**8. Workload**	**9. Duration**
Winter semester	☒	Winter and summer semester	☐	**300h**	**1 sem.**
Summer semester	☒				

Module coordination	
Teacher	PD Dr. J. Mogdans, PD Dr. V. Schluessel
Module coordinator	PD Dr. J. Mogdans
Institute/Department	IZ/Biologie

Further information	
(Reading lists, information links etc.)	Shettleworth, SJ (2010) Cognition, Evolution and Behaviour Zupanc, G.K.H. (2003) Behavioral Neurobiology, An integrative approach.

*SWS

Neuroethology:
Neural Basis of Behaviour and Sensory Perception
OEP-B03 INAKTIV

UNIVERSITÄT BONN

1. Content and intended learning outcomes

Content	This module will introduce students to the general principles of neuroethology, i.e. the neural base of animal behaviour and animal sensory systems. Students will learn about different neuroethological model systems and gain knowledge about the generation of behaviour by the nervous system and about the principles of sensory coding by the sense organs and the brain. The module will develop student's appreciation for the application of modern electrophysiological, neuroanatomical, and behavioural techniques to decipher the physiological working principles of animal brains. In the practical sessions, students learn to independently design, conduct and analyse electrophysiological, neuroanatomical, and behavioural experiments using modern scientific techniques. By writing a protocol of their own experiments in the format of a scientific publication, students learn how scientific papers and posters are designed and how the rationale, methods, results, and conclusions are presented in scientific journals.
Learning outcomes	In the lecture general principles of neuroethology are introduced to the students in a comparative way, using different invertebrate and vertebrate model systems. In the practical, each group of 3 students designs their own experiments according to the scientific 'problems' they have been given by the instructor to solve. Students will record electrophysiologically in electrosensory structures of the brain and sense organs of weakly electric and other fishes. In addition, they will use neuroanatomical tracing techniques to reconstruct the morphology of neurons, brain nuclei, and fibre connections of the fish's brain and sense organs. Stimulus methods will be used to elicit animal behaviour and to collect psychophysical data of an animal. Results will be analysed and presented by employing modern scientific methods of data analysis and computer graphics.

2. Teaching and learning methods

	Type of instruction	Topic	Language of instruction	Group size	Weekly contact time*	Workload [h]
	V	Neuroethology	en.	60	2	60
	P	Neuroethology	en.	12	4	180
	S	Neuroethology	en.	12	2	60

3. Prerequisites for the module

compulsory	OEP-M2
recommended	none

4. Degree program allocation

	Study program	compulsory/ elective	Semester
	MSc OEP-Biology	elective	2 o. 3

5. Requirements for the award of credits (ECTS)		6. Credits
Required achievements	Participation in practical experiments	**10**
Assessment (incl. weighting) and examination language	Written report (Protokoll) (100%), en.	

7. Frequency				8. Workload	9. Duration
Winter semester	☒	Winter and summer semester	☐	**300h**	**1 sem.**
Summer semester	☒				

Module coordination

Teacher	Prof. Dr. G. von der Emde
Module coordinator	Prof. Dr. G. von der Emde
Institute/Department	IZ/Biologie

Further information

(Reading lists, information links etc.)	Heldmeier G. & Neuweiler G. (2003) Vergleichende Tierphysiologie, Band 1: Neuro- und Sinnesphysiologie, Zupanc, G.K.H. (2003) Behavioral Neurobiology, An integrative approach.

*SWS

Behavioural Ecology Theory

OEP-B04

UNIVERSITÄT BONN

1. Content and intended learning outcomes

Content	Ecology determines how behaviour contributes to survival and reproduction of an organism. Behavioural Ecology studies the evolution of adaptive behaviour in an ecological context. It thus studies the function or survival value of behaviour. The following topics will be treated in the weekend seminar 1 basics: Causal and Functional Explanations of Behaviour, Testing Hypotheses, Economic Decisions, Competing for Resources, Evolutionary Arms Races, Sexual Conflict and Sexual Selection, Alternative Breeding Strategies, Aggressive Behaviour, Living in Groups, Parental Care and Mating Systems, Selfishness, Altruism and Cooperation, Helping Behaviour. Seminar 2 consists of a weekend seminar in which the students present and discuss a timely topic in Behavioural Ecology like “mate choice and sexual selection", “sperm competition", "visual signals and sexual selection", "kin recognition", "parasite-host coevolution".
Learning outcomes	The module teaches concepts and methods in all fields of behavioural sciences, like classical Ethology, Sociobiology, Behavioural Physiology, and Neuroethology. Behavioural sciences is introduced as hypothesis driven science that is either studied from a proximate or an ultimate approach.

2. Teaching and learning methods

	Type of instruction	Topic	Language of instruction	Group size	Weekly contact time*	Workload [h]
	S	Basics	en.	12	2	75
	S	Special Topics	en.	12	2	75

3. Prerequisites for the module

compulsory	OEP-M1, OEP-M2
recommended	none

4. Degree program allocation

	Study program	compulsory/ elective	Semester
	MSc OEP-Biology	elective	2 o. 3

5. Requirements for the award of credits (ECTS)		6. Credits
Required achievements	none	**5**
Assessment (incl. weighting) and examination language	Oral presentation (Referat) (50%), en. Oral presentation (Referat) (50%), en.	

7. Frequency				8. Workload	9. Duration
Winter semester	☒	Winter and summer semester	☐	**150h**	**1 sem.**
Summer semester	☒				

Module coordination

Teacher	Dr. T. Thünken, Dr. J. Brün
Module coordinator	N.N.
Institute/Department	IEZ/Biologie

Further information

(Reading lists, information links etc.)	Davies, N. B., Krebs, J. R. & West, S. A. (2012). An Introduction to Behavioural Ecology (4th ed.). Wiley-Blackwell, Oxford, UK

*SWS

Neuroanatomy

OEP-B05

UNIVERSITÄT BONN

1. Content and intended learning outcomes

Content	We will investigate mainly fish brains, but also some invertebrate model systems to get on overview of the major differences in neuronal organization between them. Sensory and motor pathways will be compared and pathways will be traced from primary sensory centers through higher integrative centers to motor command areas.
Learning outcomes	The students will learn modern experimental neuroanatomical techniques and investigate the histology and connectivity of brains. Vertebrate and invertebrate animal models will be used to demonstrate the general morphology of the brains. Further, students will apply tracer experiments with both, fluorescent and light stable reactions and to learn how to analyze neuronal pathways and connections. Histochemical methods will reveal the distribution of neurotransmitter related enzymes.

2. Teaching and learning methods

	Type of instruction	Topic	Language of instruction	Group size	Weekly contact time*	Workload [h]
	V	Neuroanatomy	en.	10	2	60
	P	Neuroanatomy	en.	10	4	180
	S	Neuroanatomy	en.	10	2	60

3. Prerequisites for the module

compulsory	OEP-M1, OEP-M2
recommended	none

4. Degree program allocation

	Study program	compulsory/ elective	Semester
	MSc OEP-Biology	elective	2 o. 3

5. Requirements for the award of credits (ECTS)		6. Credits
Required achievements	none	**10**
Assessment (incl. weighting) and examination language	Written report (Protokoll) (100%), en.	

7. Frequency				8. Workload	9. Duration
Winter semester	☒	Winter and summer semester	☐	**300h**	**1 sem.**
Summer semester	☒				

Module coordination

Teacher	Prof. Dr. M. Hofmann
Module coordinator	Prof. Dr. M. Hofmann
Institute/Department	IZ/Biologie

Further information

(Reading lists, information links etc.)	

*SWS

Palaeobiology of Invertebrates

OEP-B06

UNIVERSITÄT BONN

1. Content and intended learning outcomes

Content	The students will learn how much of the evolution, palaeoecology, and palaeobiology of invertebrate organisms is written in the stone. They will gain knowledge of the treatment of fossils in phylogenetic systematics, of different adaptations of all important invertebrate fossil taxa to a broad range of various environmental parameters, and of the effect of mass extinctions, climate changes, and other environmental perturbations on the history of invertebrates. The lectures will provide an overview on the body plans, evolution, phylogeny and fossil record of all major fossil invertebrate taxa. In the practical exercises the fossils are represented with original material from worldwide localities and with a broad range of preservational peculiarities.
Learning outcomes	Relevant methods in the practicals are comparative morphology, comparison of fossil and living taxa, palaeobiological and –ecological reconstructions, and foundations of phylogenetics. Different techniques for the analysis of invertebrate fossils will be applied ranging from light microscopy to confocal laser microscopy and X-ray examination

2. Teaching and learning methods

	Type of instruction	Topic	Language of instruction	Group size	Weekly contact time*	Workload [h]
	V	Invert. Palaeontology	en.	50	2	60
	P	Invert. Palaeontology	en.	15	4	90

3. Prerequisites for the module

compulsory	OEP-M1, OEP-M2
recommended	none

4. Degree program allocation

	Study program	compulsory/ elective	Semester
	MSc OEP-Biology	elective	2 o. 3

5. Requirements for the award of credits (ECTS)		6. Credits
Required achievements	Scientific exposé (data sheets)	**5**
Assessment (incl. weighting) and examination language	Written exam (100%), en.	

7. Frequency				8. Workload	9. Duration
Winter semester	☒	Winter and summer semester	☐	**150h**	**1 sem.**
Summer semester	☒				

Module coordination

Teacher	Prof. Dr. J. Rust
Module coordinator	Prof. Dr. J. Rust
Institute/Department	Paläontologisches Institut/Geowissenschaften

Further information

(Reading lists, information links etc.)	D. E. G. Briggs & P. R. Crowther (2001): Palaeobiology II. – Blackwell Publishing. E. N. K. Clarkson (1998): Invertebrate Palaeontology and Evolution. – Blackwell Science (4. Aufl.). B. Ziegler (1991, 1992, 1998): Einführung in die Paläobiologie (Teil 1-3). – E. Schweizerbart´sche Verlagsbuchhandlung. W. Westheide & R. Rieger (1996, 2006): Spezielle Zoologie, Erster Teil: Einzeller und Wirbellose. – Gustav Fischer Verlag.

*SWS

Vertebrate Comparative Anatomy and Functional Morphology
OEP-B07

UNIVERSITÄT BONN

1. Content and intended learning outcomes

Content	• Laboratory course: Comparative Vertebrate Anatomy • Dissection of representatives of all vertebrate classes. As 1/4 Block (1 week) or alternatively 2h (+ introduction) per week. Hard- and soft part histology • Lecture and Lab: Structural skeletal adaptation in fossil and recent vertebrates. • Function and special adaptations with respect to swimming, terrestrial locomotion , digging and flying
Learning outcomes	Goal is to understand the basic vertebrate body plan and the specializations in different major groups. Fixed specimens of representatives of all major groups will be dissected and selected tissue will be processed for histology. Differences in the organization and morphology of major organs will be discussed in the context of functional implications. We will discuss different requirements for respiration, nutrition, heat exchange, locomotion, metabolism, reproduction und much more.

2. Teaching and learning methods

	Type of instruction	Topic	Language of instruction	Group size	Weekly contact time*	Workload [h]
	V	Comp. Vert. Anat. and Hist.	en.	50	2	90
	P	Comp. Vert. Anat. and Hist.	en.	20	4	210

3. Prerequisites for the module

compulsory	OEP-M1, OEP-M2
recommended	none

4. Degree program allocation

	Study program	compulsory/ elective	Semester
	MSc OEP-Biology	elective	2 o. 3

5. Requirements for the award of credits (ECTS)		6. Credits
Required achievements	none	**10**
Assessment (incl. weighting) and examination language	Written exam (100%), en.	

7. Frequency				8. Workload	9. Duration
Winter semester	☒	Winter and summer semester	☐	**300h**	**1 sem.**
Summer semester	☒				

Module coordination

Teacher	Prof. Dr. M. Hofmann
Module coordinator	Prof. Dr. M. Hofmann
Institute/Department	IZ/Biologie

Further information

(Reading lists, information links etc.)	*Vertebrates: Comparative Anatomy, Function, Evolution*, 4th ed. by Kardong, McGraw-Hill 2006

*SWS

Marine Biology: Theory

OEP-B08

UNIVERSITÄT BONN

1. Content and intended learning outcomes

Content	The lecture gives an overview of abiotic and biotic factors, history and geology of marine ecosystems (coral reefs, mangroves, hydrothermal vents, etc.) and different environmental factors in marine habitats. Furthermore impact of human activities on marine habitats will be presented In the seminar, special topics are addressed, dealing with invasive species, pollution, medical application of marine organisms, etc.
Learning outcomes	The students get an insight into functioning of marine habitats and will achieve a sensitivity for the fragility of these habitats. They achieve a good theoretical knowledge on invertebrate systematics, functional morphology, ecological traits and constraints. They will learn to recognize special adaptations as a necessity for the organism to survive in special habitats and they should recognize the problems of anthropogenetic influence.

2. Teaching and learning methods

	Type of instruction	Topic	Language of instruction	Group size	Weekly contact time*	Workload [h]
	V	Marine Biology	en.	100	2	90
	S	Marine Biology	en.	20	2	60

3. Prerequisites for the module

compulsory	OEP-M1, OEP-M2
recommended	none

4. Degree program allocation

	Study program	compulsory/ elective	Semester
	MSc OEP-Biology	elective	2 o. 3
	MSc Plant Sciences	elective	2 o. 3

5. Requirements for the award of credits (ECTS)		6. Credits
Required achievements	Oral presentation (Referat)	**5**
Assessment (incl. weighting) and examination language	Written exam (100%), en.	

7. Frequency				8. Workload	9. Duration
Winter semester	☒	Winter and summer semester	☐	**150h**	**1 sem.**
Summer semester	☒				

Module coordination

Teacher	Prof. Dr. H. Wägele
Module coordinator	Prof. Dr. H. Wägele
Institute/Department	ZFMK/Biologie

Further information

(Reading lists, information links etc.)	Sommer U. Biologische Meereskunde. Springer Verlag Hofrichter: Das Mittelmeer Band I und II Special literature

*SWS

Diversity, Systematics and Evolution of Plants

OEP-B09/PSBE

UNIVERSITÄT BONN

1. Content and intended learning outcomes

Content	Plants are the most important structural elements and primary producers in almost all non-aquatic ecosystems. They produce food, medicine, and technical products for the over 7 billion people. Sound understanding of the phylogeny and evolution of plants helps to better understand both their ecological adaptations as well as the origin of crops and medicinal plants. Recent as well as fundamental publications on plant biodiversity, systematics, and evolution will be presented by the students and discussed during the seminar.
Learning outcomes	At the end of the module students should have a sound overview about the major lineages and families of plants (especially seed plants), their systematics, morphology, and basic ecology. They will have a good background in morphology, taxonomy, and systematics, and have a first overview about the broader field of biodiversity research, including conservation biology. They have familiarized themselves with current advances in the field and have a rough overview of the scientific literature on the topics.

2. Teaching and learning methods

	Type of instruction	Topic	Language of instruction	Group size	Weekly contact time*	Workload [h]
	S	Div., Syst. and Evol. of Plants	en.	18	2	90

3. Prerequisites for the module

compulsory	OEP-M1
recommended	none

4. Degree program allocation

	Study program	compulsory/ elective	Semester
	MSc OEP-Biology	elective	2
	MSc Plant Sciences	elective	2

5. Requirements for the award of credits (ECTS)		6. Credits
Required achievements	none	**3**
Assessment (incl. weighting) and examination language	Oral presentation (Referat) (100%), en.	

7. Frequency				8. Workload	9. Duration
Winter semester	☐	Winter and summer semester	☐	**90h**	**1 sem.**
Summer semester	☒				

Module coordination

Teacher	Prof. Dr. M. Weigend, Prof. Dr. D. Quandt
Module coordinator	Prof. Dr. M. Weigend, Prof. Dr. D. Quandt
Institute/Department	Nees-Institut/Biologie

Further information

(Reading lists, information links etc.)	JUDD, W.S., CAMPBELL, C.S., KELLOG, E.A. & STEVENS, P.F. : Plant Systematics. A phylogenetic approach. Sinauer Associates, Inc., Massachusetts (USA). KUBITZKI, K. (ed.) (1993 -): The families and genera of vascular plants. Several Volumes. - Springer; Heidelberg. KADEREIT, J.W., KÖRNER, C.,KOST, B., SONNEWALD, U.: Strasburger Lehrbuch der Pflanzenwissenschaften. - Springer Spektrum.

*SWS

Organismic Botany 2: Vegetation and Plant Ecology

OEP-B10/OB2

UNIVERSITÄT BONN

1. Content and intended learning outcomes

Content	The course deals with the field of vegetation ecology. This includes an introduction to global vegetation geography. The factors influencing plant dispersal, establishment and distribution and the composition of vegetation units including human influence on terrestrial ecosystems are presented. The characteristic plant groups for specific ecosystems are introduced and their ecological characteristics discussed.
Learning outcomes	By the end of the modul, the students should have a sound understanding of the influence of the abiotic environment on plant communities and vegetation structure. They should be able to map the distribution and describe the nature of earth's major terrestrial biomes. They should have a basic understanding of anthropogenic influence on terrestrial ecosystems.

2. Teaching and learning methods

	Type of instruction	Topic	Language of instruction	Group size	Weekly contact time*	Workload [h]
	V	Plant Ecology and Vegetation	en.	30	2	150

3. Prerequisites for the module

compulsory	OEP-M2
recommended	none

4. Degree program allocation

	Study program	compulsory/ elective	Semester
	MSc OEP-Biology	elective	2
	MSc Plant Sciences	compulsory	2
	MSc Naturschutz und Landschaftsökologie	elective	2

5. Requirements for the award of credits (ECTS)		6. Credits
Required achievements	none	**5**
Assessment (incl. weighting) and examination language	Written exam (100%), en.	

7. Frequency				8. Workload	9. Duration
Winter semester	☐	Winter and summer semester	☐	**150h**	**1 sem.**
Summer semester	☒				

Module coordination

Teacher	Prof. Dr. M. Weigend
Module coordinator	Prof. Dr. M. Weigend
Institute/Department	Nees-Institut/Biologie

Further information

(Reading lists, information links etc.)	LOMOLINO, RIDDLE, WHITTAKER & BROWN. Biogeography, Sinauer. MILLINGTON, BLUMLER & SCHICKHOFF (eds.). Handbook of Biogeography. Sage Publications: London FREY & LÖSCH : Lehrbuch der Geobotanik. Elsevier, Spektrum Verlag. SCHULZE, BECK & MÜLLER-HOHENSTEIN: Plant Ecology. Springer. 702 pp WALTER & BRECKLE: Vegetationszonen und Klima. UTB, Ulmer, Stuttgart KADEREIT, J.W., KÖRNER, C.,KOST, B., SONNEWALD, U.: Strasburger Lehrbuch der Pflanzenwissenschaften. - Springer Spektrum.

*SWS

Plant Biochemistry, Physiology and Molecular Biology

OEP-B11/PBPM0

UNIVERSITÄT BONN

1. Content and intended learning outcomes

Content	The lecture will address all major topics of plant biochemistry, physiology and molecular biology including: biochemical pathways of primary and secondary metabolism, photosynthesis, respiratory chain, carbohydrates, plant hormones, membrane and storage lipids, membranes, long-distance and membrane transport, cell wall biosynthesis and external biopolymers, nitrogen and sulfur assimilation, abiotic and biotic environmental interactions, physiological stress, plant-microbe interactions and plant pathogens, plant genomes and gene expression, model organisms in plant research, gene technology and transgenic plants.
Learning outcomes	Students should gain a solid understanding of the physiological processes in plants on the basis of a well-founded, current knowledge of the molecular structures, reactions and processes in plant cells and tissues.

2. Teaching and learning methods

	Type of instruction	Topic	Language of instruction	Group size	Weekly contact time*	Workload [h]
	V	Plant Biochem., Physiol. & Mol. Biol.	en.	60	3	150

3. Prerequisites for the module

compulsory	OEP-M1, OEP-M2
recommended	none

4. Degree program allocation

	Study program	compulsory/ elective	Semester
	MSc OEP-Biology	elective	3
	MSc Plant Sciences	elective	1

5. Requirements for the award of credits (ECTS)		6. Credits
Required achievements	none	**5**
Assessment (incl. weighting) and examination language	Written exam (100%), en.	

7. Frequency				8. Workload	9. Duration
Winter semester	☒	Winter and summer semester	☐	**150h**	**1 sem.**
Summer semester	☐				

Module coordination

Teacher	Prof. Dr. L. Schreiber; Prof. Dr. V. Knoop, N.N.
Module coordinator	Prof. Dr. L. Schreiber
Institute/Department	IZMB/Biologie

Further information

(Reading lists, information links etc.)	Bob B. Buchanan, Wilhelm Gruissem, and Russel L. Jones. Biochemistry and Molecular Biology of Plants, Rockville, MD:American Society of Plant Physiologists, 2000. Taiz L, Zeiger E (2002) Plant Physiology. Sinauer Associates Inc., Sunderland, MA

*SWS

Systematics and Biology of Plants

OEP-B12/PBIO

UNIVERSITÄT BONN

1. Content and intended learning outcomes

Content	The course provides an overview on the morphology, systematics and biology (especially reproductive biology) of plants based primarily on living material from the botanic gardens, as well as herbarium material. Methods for the documentation and analysis of plant diversity from the fields of morphology, taxonomy, and, e.g., fruit and floral biology are taught.
Learning outcomes	At the end of the module students should have a sound overview over the major lineages and families of land plants, their systematics, morphology, and basic ecology. They will be familiar with the most important methods and terminology in the field of descriptive and functional morphology, taxonomy, and systematics.

2. Teaching and learning methods

	Type of instruction	Topic	Language of instruction	Group size	Weekly contact time*	Workload [h]
	P	Syst. and Biol. of Seed Plants	en.	12	8	300

3. Prerequisites for the module

compulsory	OEP-M1
recommended	none

4. Degree program allocation

	Study program	compulsory/ elective	Semester
	MSc OEP-Biology	elective	2
	MSc Plant Sciences	elective	2

5. Requirements for the award of credits (ECTS)		6. Credits
Required achievements	none	**10**
Assessment (incl. weighting) and examination language	Oral presentation (Präsentation) and/or poster (50%), en. Written report (Protokoll) (50%), en.	

7. Frequency				8. Workload	9. Duration
Winter semester	☐	Winter and summer semester	☐	**300h**	**1 sem.**
Summer semester	☒				

Module coordination

Teacher	Prof. Dr. M. Weigend, Prof. Dr. D. Quandt
Module coordinator	Prof. Dr. M. Weigend, Prof. Dr. D. Quandt
Institute/Department	Nees-Institut/Biologie

Further information

(Reading lists, information links etc.)

JUDD, W.S., CAMPBELL, C.S., KELLOG, E.A. & STEVENS, P.F. : Plant Systematics. A phylogenetic approach. Sinauer Associates, Inc., Massachusetts (USA).

KUBITZKI, K. (ed.) (1993 -): The families and genera of vascular plants. Several Volumes. - Springer; Heidelberg.

KADEREIT, J.W., KÖRNER, C.,KOST, B., SONNEWALD, U.: Strasburger Lehrbuch der Pflanzenwissenschaften. - Springer Spektrum

*SWS

Palaeobotany and Palynology

OEP-B13/PAPA

UNIVERSITÄT BONN

1. Content and intended learning outcomes

Content	Palaeobotany and palynology play a fundamental role to understand the evolution of plants from the earliest forms to the development of our present flora. Based on fossil material the plant evolution will be placed in the context of time, climate change and mass extinction. The course focuses on periods when major evolutionary changes occurred and addresses the rates and timing of the evolutionary change seen in the plant fossil records.
Learning outcomes	Participants should gain an understanding of the evolution of land plants based on macro- and micropalaeobotanical data, and the application of this information to phylogenetic and evolutionary analysis. Aims include to develop skills in (1) morphological analysis of fossil plants, (2) introduction into the pollen morphology and pollen analysis (3) using SEM and Confocal Laser-Scanning Microscop (4) evaluation of palaeobotanical data in comparison with current research on ancient DNA and other biomolecular markers.

2. Teaching and learning methods

	Type of instruction	Topic	Language of instruction	Group size	Weekly contact time*	Workload [h]
	V	Palaeobotany and terrestrial palaeoecology	en.	50	1	30
	P	Palaeobotany and Palynology	en.	15	4	120

3. Prerequisites for the module

compulsory	OEP-M1
recommended	none

4. Degree program allocation

	Study program	compulsory/ elective	Semester
	MSc OEP-Biology	elective	2
	MSc Plant Sciences	elective	2 o. 4

5. Requirements for the award of credits (ECTS)		6. Credits
Required achievements		**5**
Assessment (incl. weighting) and examination language	Written exam (Klausur) (50%), en. Written report (Protokoll) (50%), en.	

7. Frequency				8. Workload	9. Duration
Winter semester	☐	Winter and summer semester	☐	**150h**	**1 sem.**
Summer semester	☒				

Module coordination

Teacher	Prof. Dr. T. Litt
Module coordinator	Prof. Dr. T. Litt
Institute/Department	Paläontologisches Institut/Geowissenschaften

Further information

(Reading lists, information links etc.)	Moore, Webb, Collinson: Pollen Analysis Steward, Rothwell: Paleobotany and the Evolution of Plants Steward, Rothwell: Paleobotany and the Evolution of Plants Taylor, Taylor: The Biology and Evolution of Fossil Plants Willis, McElwain: The Evolution of Plants

*SWS

Plant Biodiversity and Conservation

OEP-B14/PBDC

UNIVERSITÄT BONN

1. Content and intended learning outcomes

Content	The Seminar gives an introduction to basic concepts and approaches of nature conservation. A major focus will be on the international agreements and actors related to conservation of biological diversity.
Learning outcomes	By the end of the seminar, the students have a first overview about conservation biology and related (international) agreements and organisations.

2. Teaching and learning methods

	Type of instruction	Topic	Language of instruction	Group size	Weekly contact time*	Workload [h]
	S	Biodiv. and Conserv.	en.	15	2	90

3. Prerequisites for the module

compulsory	OEP-M1
recommended	none

4. Degree program allocation

Study program	compulsory/ elective	Semester
MSc OEP-Biology	elective	3
MSc Plant Sciences	elective	1 o. 3
MSc Naturschutz und Landschaftsökologie	elective	1 o. 3

5. Requirements for the award of credits (ECTS)		6. Credits
Required achievements	none	**3**
Assessment (incl. weighting) and examination language	Oral presentation (Referat) (100%)	

7. Frequency				8. Workload	9. Duration
Winter semester	☒	Winter and summer semester	☐	**90h**	**1 sem.**
Summer semester	☐				

Module coordination

Teacher	Dr. J. Mutke, Dr. C. Löhne
Module coordinator	Dr. J. Mutke
Institute/Department	Nees-Institut/Biologie

Further information

(Reading lists, information links etc.)

JUDD, W.S., CAMPBELL, C.S., KELLOG, E.A. & STEVENS, P.F. : Plant Systematics. A phylogenetic approach. Sinauer Associates, Inc., Massachusetts (USA).

KUBITZKI, K. (ed.) (1993 -): The families and genera of vascular plants. Several Volumes. - Springer; Heidelberg.

KADEREIT, J.W., KÖRNER, C.,KOST, B., SONNEWALD, U.: Strasburger Lehrbuch der Pflanzenwissenschaften. - Springer Spektrum

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Vertebrate Palaeontology I: Palaeobiology and Evolution of the Vertebrates
OEP-B15

UNIVERSITÄT BONN

1. Content and intended learning outcomes

Content	Theoretical background of the evolutionary history of the vertebrates. Occurrence of major vertebrate groups in time and space, historical biogeography and dispersal. Phylogeny of major clades of vertebrates, presentation of competing hypotheses. Functional morphology and adaptation. Practical course in comparative osteology of the tetrapods with fossil and Recent material. Discussion of the phylogenetic background and functional adaptations that can be recognized from the analysis of the skeleton. Drawing and labelling of selected specimens. Study of vertebrate fossil deposits in the field, synthesis of the field trip in a report.
Learning outcomes	General understanding of the evolutionary history, phylogeny, and historical biogegraphy of the vertebrates. Detailed knowledge of the comparative anatomy and functional morphology of the skeletal system of the tetrapods. Vertebrate fossil deposits in the field.

2. Teaching and learning methods

	Type of instruction	Topic	Language of instruction	Group size	Weekly contact time*	Workload [h]
	V	Vert. Palaeontology	en.	20	3	60
	P	Vert. Palaeontology	en.	20	2	90

3. Prerequisites for the module

compulsory	OEP-M1, OEP-M2
recommended	none

4. Degree program allocation

	Study program	compulsory/ elective	Semester
	MSc OEP-Biology	elective	2 o. 3

5. Requirements for the award of credits (ECTS)		6. Credits
Required achievements	Oral presentation (Referat)	**5**
Assessment (incl. weighting) and examination language	Written exam (100%), en.	

7. Frequency				8. Workload	9. Duration
Winter semester	☒	Winter and summer semester	☐	**150h**	**1 sem.**
Summer semester	☒				

Module coordination

Teacher	Prof. Dr. T. Martin; Dr. J. Schultz
Module coordinator	Prof. Dr. T. Martin
Institute/Department	Paläontologisches Institut/Geowissenschaften

Further information

(Reading lists, information links etc.)	M. J. Benton, Vertebrate Paleontology, Blackwell Science, 3rd edition 2004 R. L. Carroll, Paläontologie und Evolution der Wirbeltiere, Thieme 1993

*SWS

Evolution and Biodiversity of Lower Vertebrates

OEP-B16

UNIVERSITÄT BONN

1. Content and intended learning outcomes

Content	More than two-thirds of the vertebrate species known are fishes, amphibians or reptiles. Lectures and seminars of this module will provide an overview on patterns of diversity, systematics and evolution of these “lower vertebrates”. Comparative anatomical studies will be performed in the practical part to explore morphological traits relevant in context of adaptation or systematics. Methods taught comprise those relevant for collection-based research, key “tools” relevant for evolutionary and systematic studies, and applied aspects relevant to zoos.
Learning outcomes	The participants will gain insight into evolution and diversity of lower vertebrates (fishes, amphibians and reptiles). Morphological adaptation and geographical distribution are discussed in context of ecological and biogeographical concepts. Lectures and seminars will provide a general overview on patterns and processes related to lower vertebrate diversity, but will also allow deeper insight into some relevant key groups.

2. Teaching and learning methods

	Type of instruction	Topic	Language of instruction	Group size	Weekly contact time*	Workload [h]
	V	Lower Vertebrates	en.	20	1	60
	S	Lower Vertebrates	en.	20	1	60
	P	Lower Vertebrates	en.	20	6	180

3. Prerequisites for the module

compulsory	OEP-M1, OEP-M2
recommended	none

4. Degree program allocation

	Study program	compulsory/ elective	Semester
	MSc OEP-Biology	elective	2 o. 3

5. Requirements for the award of credits (ECTS)		6. Credits
Required achievements	none	**10**
Assessment (incl. weighting) and examination language	Oral presentation (Referat) (50%), en. Written report (Protokoll) (50%), en.	

7. Frequency				8. Workload	9. Duration
Winter semester	☒	Winter and summer semester	☐	**300h**	**1 sem.**
Summer semester	☒				

Module coordination

Teacher	PD Dr. F. Herder, Dr. D. Rödder
Module coordinator	PD Dr. F. Herder, Dr. D. Rödder
Institute/Department	ZFMK/Biologie

Further information

(Reading lists, information links etc.)	Will be announced before start of course

*SWS

Evolution, Diversity, and Biology of Arthropods

OEP-B17

UNIVERSITÄT BONN

1. Content and intended learning outcomes

Content	Arthropods (Insects, millipedes, centipedes, crustaceans, arachnids) are the most diverse animal group on our planet containing three quarters of all known species. This module aims to give students a general overview of the evolution and diversity of arthropods with a combination of field excursions and lab work. In particular, students will learn: • How to collect, dissect and conserve/mount arthropods • How to identify major arthropod lineages and species • How to extract morphological characters and to infer differences between different character states with computer-tools (morphometrics) Based on self-collected material and additional specimens the students will study the external morphology of selected taxa with light- microscopic methods to gain a deeper understanding of arthropod taxonomy. The module will also focus on phylogenetic systematics based on morphology with example data. The field excursions around Bonn will also serve to gain a deeper understanding of ecological niches of selected arthropod species (mainly millipedes and insects).
Learning outcomes	In-depth understanding of the evolution, diversity, and biology of arthropods in general and of some groups in particular (millipedes, beetles, flies & wasps). In addition, students will learn how to identify and study arthropods, i.e. how to infer characters, to understand their evolutionary history etc. by means of comparative and phylogenetic analyses.

2. Teaching and learning methods

	Type of instruction	Topic	Language of instruction	Group size	Weekly contact time*	Workload [h]
	V	Evol., Div., Biol. of Arthropods	en.	14	2	60
	S	Evol., Div., Biol. of Arthropods	en.	14	2	60
	P	Evol., Div., Biol. of Arthropods	en.	14	4	180

3. Prerequisites for the module

compulsory	OEP-M1, OEP-M2
recommended	none

4. Degree program allocation

	Study program	compulsory/ elective	Semester
	MSc OEP-Biology	elective	2 o. 3

5. Requirements for the award of credits (ECTS)		6. Credits
Required achievements	none	**10**
Assessment (incl. weighting) and examination language	Two oral presentations (Referate) (40%), en. One divided exam (60%), en.	

7. Frequency				8. Workload	9. Duration
Winter semester	☐	Winter and summer semester	☐	**300h**	**1 sem.**
Summer semester	☒				

Module coordination

Teacher	Dr. T. Wesener, Prof. Dr. A. Blanke, Dr. D. Ahrens, Dr. X. Mengual, Dr.R. Peters, B.Rulik
Module coordinator	Dr. T. Wesener
Institute/Department	ZFMK/Biologie

Further information

(Reading lists, information links etc.)	Will be announced before start of course

*SWS

Speciation in Fishes: Patterns and Processes

OEP-B18

UNIVERSITÄT BONN

1. Content and intended learning outcomes

Content	Speciation research asks for the mechanisms and processes generating biodiversity. Fishes are with roughly 30.000 species by far the most diverse group of vertebrates in the world, and have extensively been used as model organisms to test hypotheses on the origin of species. In this seminar, we review speciation theory and discuss theoretical predictions in context of current literature on speciation in fishes. Examples considered range from adaptive radiations in African rift lakes to evolution of species pairs in northern lake whitefish or recently discovered cases of hybrid speciation.
Learning outcomes	This seminar will provide background in speciation theory and encourage to critically discuss alternative hypotheses on the origin of diversity in context of fish model systems.

2. Teaching and learning methods

	Type of instruction	Topic	Language of instruction	Group size	Weekly contact time*	Workload [h]
	S	Speciation in Fishes	en.	16	2	75

3. Prerequisites for the module

compulsory	OEP-M1, OEP-M2
recommended	none

4. Degree program allocation

	Study program	compulsory/ elective	Semester
	MSc OEP-Biology	elective	2 o. 3

5. Requirements for the award of credits (ECTS)		6. Credits
Required achievements	none	**2.5**
Assessment (incl. weighting) and examination language	Oral presentation (Referat) (50%), en. Written report (Protokoll) (50%), en.	

7. Frequency				8. Workload	9. Duration
Winter semester	☒	Winter and summer semester	☐	**300h**	**1 sem.**
Summer semester	☒				

Module coordination

Teacher	PD Dr. F. Herder
Module coordinator	PD Dr. F. Herder
Institute/Department	ZFMK/Biologie

Further information

(Reading lists, information links etc.)	Will be announced before start of course

*SWS

Patterns and Processes Shaping Biodiversity

OEP-B19

UNIVERSITÄT BONN

1. Content and intended learning outcomes

Content	Lectures will provide an overview on historical biogeography, (macro-) ecology, phylogenetic systematics, speciation and species richness in vertebrates. The chosen taxa, as well as the focus of the subject, depend on the lecturers as well as on the literature chosen by the students. Main topics (lectures and literature) are (i) plate tectonics and distribution patterns of vertebrates, (ii) biogeographic history of ecoregions, (iii) mechanism generating diversity patterns of selected vertebrate taxa, (iv) climatic history, and (v) speciation. Adaptations to ecologically extreme environments (like deserts) and climatic change and its ecological implications will also be addressed in detail.
Learning outcomes	This seminar focuses to patterns of diversity in vertebrates. Participants are introduced to the fields of historical biogeography and speciation, which will be discussed in context of species richness patterns, ecology and phylogeography. Students will learn to read scientific literature on theory and case studies of vertebrates, to give oral presentations, and to discuss the topics critically.

2. Teaching and learning methods

	Type of instruction	Topic	Language of instruction	Group size	Weekly contact time*	Workload [h]
	S	Speciation in Fishes	en.	16	2	75

3. Prerequisites for the module

compulsory	OEP-M1, OEP-M2
recommended	none

4. Degree program allocation

	Study program	compulsory/ elective	Semester
	MSc OEP-Biology	elective	2 o. 3

5. Requirements for the award of credits (ECTS)		6. Credits
Required achievements	none	**2,5**
Assessment (incl. weighting) and examination language	Oral presentation (Referat) (100%), en.	

7. Frequency				8. Workload	9. Duration
Winter semester	☒	Winter and summer semester	☐	**150h**	**1 sem.**
Summer semester	☒				

Module coordination

Teacher	PD Dr. F. Herder, Dr. D. Rödder
Module coordinator	PD Dr. F. Herder, Dr. D. Rödder
Institute/Department	ZFMK/Biologie

Further information

(Reading lists, information links etc.)	Will be announced before start of course

*SWS

Form and Function in Birds: an Evolutionary Perspective

OEP-B20

UNIVERSITÄT BONN

1. Content and intended learning outcomes

Content	This course deals with the basics of species diversity and classification of birds illustrated by selected evolutionary, ecological and functional aspects. Participants will develop an understanding of avian morphology as a result of adaptive processes shaped in time by ecological and behavioural constraints. Finally, students shall be enabled to draw conclusions on the systematic position and on the general lifestyle of birds based on external avian characters. The course will also include an all-day mandatory excursion to the Cologne Zoo. There will be morning lectures introducing specific day topics that are dealt with during the practical part. The day's content is complemented by joint discussions of students' presentations. Participants are expected to give one presentation on selected articles matching the days' topics, with subjects ranging from classic morphological and ecological papers to current molecular phylogenetic and evolutionary articles. Moreover, a final talk presenting self-accessed information on their exemplary specimen in the context of the course's content should be given by each work group.
Learning outcomes	Evolutionary and functional interrelationships of selected groups of birds will be studied by own hands-on studies. Defining adaptations and specializations of selected birds will be examined in detail by the students based on exemplary specimens that accompany student work groups throughout the course.

2. Teaching and learning methods

	Type of instruction	Topic	Language of instruction	Group size	Weekly contact time*	Workload [h]
	V	Bird Form & Function	en.	14	2	60
	S	Bird Form & Function	en.	14	2	60
	prÜ, E	Bird Form & Function	en.	14	5	180

3. Prerequisites for the module

compulsory	OEP-M1, OEP-M2
recommended	none

4. Degree program allocation

	Study program	compulsory/ elective	Semester
	MSc OEP-Biology	elective	2 o. 3

5. Requirements for the award of credits (ECTS)		6. Credits
Required achievements	none	**10**
Assessment (incl. weighting) and examination language	Two oral presentations (Referate) (25% each), en. Written exam (50%), en.	

7. Frequency				8. Workload	9. Duration
Winter semester	☒	Winter and summer semester	☐	**300h**	**1 sem.**
Summer semester	☒				

Module coordination

Teacher	Dr. T. Töpfer
Module coordinator	Dr. T. Töpfer
Institute/Department	ZFMK/Biologie

Further information

(Reading lists, information links etc.)	Will be announced before start of course

*SWS

Specialization in Vertebrate Paleontology: Mammals

OEP-B21/MP13/M61

UNIVERSITÄT BONN

1. Content and intended learning outcomes

Content	Faunen- und Verbreitungsgeschichte der wichtigsten Säugetiergruppen. Zusammenhänge zwischen Plattentektonik und Paläobiogeographie der Säuger. Evolution der Synapsiden, Ökomorphologie und Phylogenie mesozoischer Säugetiere. Vergleichend-odontologische und funktionsmorphologische Betrachtungen am Gebiss der Säugetiere. Untersuchungen an umfangreichem, fossilem und rezenten Zahn- und Schädelmaterial. Verschiedene Zahnkategorien des Gebisses, unterschiedliche Zahntypen in Abwandlung des tribosphenischen Grundmusters. Zeichnen ausgewählter Stücke.
Learning outcomes	Vertieftes Kennenlernen der mesozoischen Säugetier-Evolution, der Paläobiogeographie der Säugetiere sowie des Säugetiergebisses und der vergleichenden Odontologie der Säugetiere.

2. Teaching and learning methods

	Type of instruction	Topic	Language of instruction	Group size	Weekly contact time*	Workload [h]
	V, prÜ	Odontologie der Säugetiere	en.	30	3	90
	V	Mammals of the Mesozoic	en.	30	1	15
	V	Verbreitungsgeschichte der Säugetiere	en.	30	1	15
	S	Special Topics in Vertebrate Paleontology	en.	30	1	30

3. Prerequisites for the module

compulsory	OEP-M1, OEP-M2
recommended	none

4. Degree program allocation

	Study program	compulsory/ elective	Semester
	MSc OEP-Biology	elective	2 o. 3

5. Requirements for the award of credits (ECTS)		6. Credits
Required achievements	none	**5**
Assessment (incl. weighting) and examination language	Written exam (60%), en. Oral presentation (Präsentation) (30%), en. Oral presentation (Referat) (10%), en.	

7. Frequency				8. Workload	9. Duration
Winter semester	☒	Winter and summer semester	☐	**150h**	**1 sem.**
Summer semester	☒				

Module coordination

Teacher	Prof. Dr. T. Martin
Module coordinator	Prof. Dr. T. Martin
Institute/Department	Paläontologisches Institut/Geowissenschaften

Further information

(Reading lists, information links etc.)	Alt, K. & Türp, J.: Evolution der Zähne (Quintessenz) Chinsamy-Turan, A.: Forerunners of Mammals (Indiana University Press) Hugget, R.: Fundamentals of Biogeography (Routledge) Thenius, E.: Grundzüge der Faunen- und Verbreitungsgeschichte der Säugetiere (Fischer) Thenius, E.: Zähne und Gebiss der Säugetiere (DeGruyter)

*SWS

Specialization in Vertebrate Paleontology: Dinosaurs

OEP-B22/MP12/M63

UNIVERSITÄT BONN

1. Content and intended learning outcomes

Content	Evolution, Verbreitungsgeschichte und Aussterben der Dinosaurier, säugetierähnlichen Reptilien und marinen Reptilien des Mesozoikums, Ursprung und frühe Evolution der Vögel. Paläobiologische Fragen und Kontroversen wie Evolution der Warmblütigkeit, Zusammenhang zwischen Reproduktionsbiologie und Evolution. Methoden der Paläobiolohischen Forschung an fossilen Großreptilien. Histologie der Knochen und Zähne fossiler Wirbeltiere und ihre Aussagekraft über Individualentwicklung und Lebenslaufgeschichte. Anwendungen auf evolutive Fragen, Stichwort „Evo-Devo". Theorie und Praxis der phylogenetischen Analyse mittels Computer bei fossilen Wirbeltieren. Praktisches Vorgehen bei der histologischen Beprobung und Untersuchung fossiler Knochen und Zähne.
Learning outcomes	Vertieftes Kennenlernen der Großreptilien des Paläo- und Mesozoikums, insbesondere der Dinosaurier, marinen Reptilien und säugetierähnlichen Reptilien. Methoden der Phylogenie-Rekonstruktion an Fossilien, paläohistologische Methoden.

2. Teaching and learning methods

Type of instruction	Topic	Language of instruction	Group size	Weekly contact time*	Workload [h]
~~V~~	~~Evolution and Paleobiology of the Dinosaurs~~	~~en.~~	~~30~~	~~3~~	~~45~~
~~V, prÜ~~	~~Practical Paleohistology~~	~~en.~~	~~10~~	~~1~~	~~45~~
~~V, prÜ~~	~~Practical Phylogenetic Methods in Paleontology~~	~~en.~~	~~30~~	~~1~~	~~30~~
S	Research Seminar Vertebrate Paleontology II	en.	30	1	30

3. Prerequisites for the module

compulsory	none
recommended	none

4. Degree program allocation

Study program	compulsory/ elective	Semester
MSc OEP-Biology	elective	2 o. 3

5. Requirements for the award of credits (ECTS)		6. Credits
Required achievements	none	**10**
Assessment (incl. weighting) and examination language	Written exam (60%), en. Oral presentation (Präsentation) (30%), en. Oral presentation (Referat) (10%), en.	

7. Frequency				8. Workload	9. Duration
Winter semester	☒	Winter and summer semester	☐	**300h**	**1 sem.**
Summer semester	☒				

Module coordination

Teacher	Dr. D. Konietzko-Meier
Module coordinator	Dr. D. Konietzko-Meier
Institute/Department	Paläontologisches Institut/Geowissenschaften

Further information

(Reading lists, information links etc.)	Chinsamy-Turan, A. 2005. The microstructure of dinosaur bone. Johns Hopkins University Press, Baltimore. Currey, J.D. 2002. Bones. Structure and Mechanics. Princeton University Press, Princeton. Fastovsky, D.E. and Weishampel, D.B. 2005. The Evolution and Extinction of the Dinosaurs. Second Edition. Cambridge University Press, Cambridge. Wägele, Johann-Wolfgang. 2005. Foundations of Phylogenetic Systematics. Freidrich Pfeil Verlag, München 365 pp. Peter Skelton, Andrew Smith, and Neale Monks: 2002. Cladistics. A Practical Primer on CD-ROM. Cambridge University Press, Cambridge.

*SWS

Vertebrate Paleontology II: Vertebrate Fossil Deposits Through Time
OEP-B23/MP11/M62

UNIVERSITÄT BONN

1. Content and intended learning outcomes

Content	Definition and type of Fossillagerstätte. List of treated Lagerstätten: Präkambrium: Ediacara (Australien). Kambrium: Chengjiang (China), Burgess Shale (Kanada), Orsten (Schweden). Ordovizium, Silur: Harding Sandstone (USA). Devon: Hunsrückschiefer (Deutschland), Rhynie Chert (Schottland), Eifel-Kalkmulden (Deutschland). Karbon: Bear Gulch (USA), Ruhrkarbon (Deutschland). Perm: Unterperm von Texas (USA), Rotliegend-Seen (Deutschland), Oberperm von Russland. Trias: Petrified Forest (Arizona, USA), Monte San Giorgio (Schweiz/Italien). Jura: Holzmaden (Deutschland), Solnhofen (Deutschland), Morrison-Formation (USA). Kreide: Jehol-Biota (China), Dinosaur Provincial Park (Kanada). Tertiär: Messel (Deutschland), Tertiär des Bighorn Basin (USA), Baltischer Bernstein, Santa Cruz-Formation (Argentinien). Quartär: Rancho La Brea (USA).
Learning outcomes	Participants should gain knowledge of the most important Fossillagerstätten through earth history on the basis of collection material, field work and scientific literature. They will learn the faunistic content, the sedimentary environment, the taphonomy, the palaeogeography, and the importance of a particular Lagerstätte for our understanding of the history of life. Furthermore, they will acquire basic skills in scientific presentation and publication.

2. Teaching and learning methods

	Type of instruction	Topic	Language of instruction	Group size	Weekly contact time*	Workload [h]
	V, Ü	Fossil Lagerstätten	en.	30	1	30
	E	Fossil Lagerstätten	en.	10	3	90
	S	Research Seminar Vertebrate Paleontology II	en.	30	1	30

3. Prerequisites for the module

compulsory	none
recommended	none

4. Degree program allocation

	Study program	compulsory/ elective	Semester
	MSc OEP-Biology	elective	2 o. 3

5. Requirements for the award of credits (ECTS)		6. Credits
Required achievements	Oral presentation (Referat)	**5**
Assessment (incl. weighting) and examination language	Written exam (50%), en. Written report (50%), en.	

7. Frequency				8. Workload	9. Duration
Winter semester	☒	Winter and summer semester	☐	**150h**	**1 sem.**
Summer semester	☒				

Module coordination

Teacher	N.N.
Module coordinator	N.N.
Institute/Department	Paläontologisches Institut/Geowissenschaften

Further information

(Reading lists, information links etc.)	Selden et al. : Fossil Deposits Briggs et al.: Paleobiology - A Synthesis W.K. Weidert Hrsg : Reihe "Klassische Fundstellen d. Paläontologie" Spezialliteratur zu einzelnen Lagerstätten

*SWS

Plant-Animal Interactions in Deep Time: Fossil Record, Coevolution, Ecological Relationships
OEP-B24

UNIVERSITÄT BONN

1. Content and intended learning outcomes

Content	The course will explore the paleontological record of terrestrial plant-animal interactions, starting with the Silurian and continuing into the Paleozoic, through the Mesozoic and Cenozoic. Lectures will include, for example, the development of plant-insect herbivory during the Paleozoic, the advent of the first tetrapod herbivores in the Permian, the food ecology of the sauropod-dominated ecosystems of the Late Triassic, Jurassic and Cretaceous, the coevolution of angiosperms and insects during the Cretaceous and Cenozoic, the advent of grasslands and grazers, as well as large-nut bearing trees and rodents in the Miocene. Weekly labs give students an opportunity to learn hands-on research methods, as well as to gain familiarity with fossil plants and insects. The course is team-taught by paleontologists with research expertise in paleobotany, paleoentomology, and vertebrate paleontology.
Learning outcomes	The objective of this module is to give students a broad understanding of the types and evolution of interactions between terrestrial plants and animals in earth history, such as herbivory and pollination, and the ramifications that these evolutionary developments have for today's ecological communities.

2. Teaching and learning methods

	Type of instruction	Topic	Language of instruction	Group size	Weekly contact time*	Workload [h]
	V	Paleohistology	en.	14	4	90
	P	Paleohistology	en.	14	2	60

3. Prerequisites for the module

compulsory	OEP-M1, OEP-M2
recommended	none

4. Degree program allocation

	Study program	compulsory/ elective	Semester
	MSc OEP-Biology	elective	2 o. 3

5. Requirements for the award of credits (ECTS)		6. Credits
Required achievements	none	**5**
Assessment (incl. weighting) and examination language	Written exam (100%), en.	

7. Frequency				8. Workload	9. Duration
Winter semester	☒	Winter and summer semester	☐	**150h**	**1 sem.**
Summer semester	☒				

Module coordination

Teacher	PD Dr. C. Gee, Prof. Dr. J. Rust
Module coordinator	PD Dr. C. Gee, Prof. Dr. J. Rust
Institute/Department	Paläontologisches Institut/Geowissenschaften

Further information

(Reading lists, information links etc.)	will be announced before start of course

*SWS

Research Seminar on Plant-Insect Interactions in the Fossil Record **OEP-B25**	UNIVERSITÄT BONN

1. Content and intended learning outcomes	
Content	This module will explore the paleontological record of terrestrial plant-insect interactions, starting with the Paleozoic, extending through the Mesozoic and Cenozoic, and also include living plants and insects. The weekly class meetings will give students the opportunity to learn about traditional methods and innovative approaches being used in plant and invertebrate paleontology, as well as to share their own research experience and insights on a regular basis. Supplementary reading of classic and current scientific papers will support their scholarly development and personal knowledge base in these fields.
Learning outcomes	The objective of this weekly research seminar is to give students a broad understanding of the types of interactions that have occurred between terrestrial plants and insects in earth history, such as herbivory, pollination, and protection, as well as of the implications that these evolutionary developments have for today's ecological communities.

2. Teaching and learning methods						
	Type of instruction	Topic	Language of instruction	Group size	Weekly contact time*	Workload [h]
	S, Ü	Plant-Insect Interactions	en.	25	2	75

3. Prerequisites for the module	
compulsory	OEP-M1, OEP-M2
recommended	none

4. Degree program allocation			
	Study program	compulsory/ elective	Semester
	MSc OEP-Biology	elective	2 o. 3

5. Requirements for the award of credits (ECTS)		**6. Credits**
Required achievements	none	**2.5**
Assessment (incl. weighting) and examination language	Oral presentation (Referat) (100%), en.	

7. Frequency				**8. Workload**	**9. Duration**
Winter semester	☒	Winter and summer semester	☐	**75h**	**1 sem.**
Summer semester	☒				

Module coordination	
Teacher	PD Dr. C. Gee, Prof. Dr. J. Rust
Module coordinator	PD Dr. C. Gee
Institute/Department	Paläontologisches Institut/Geowissenschaften

Further information	
(Reading lists, information links etc.)	will be announced before start of course

*SWS

Evolution of Mammals

OEP-B26 INAKTIV

UNIVERSITÄT BONN

1. Content and intended learning outcomes

Content	Phylogeny and comparative anatomy of Mammals: Skull and skeleton morphology; Mammalian adaptations to different environments, e.g. variation of teeth adapted to feeding habits, modification of limbs due to running / flying /swimming Discussion of species concepts (theory and practice) Phylogenetic reconstruction: morphology and molecular data Critically interpreting primary publications (e.g. discussion of different phylogenetic hypotheses for the same taxa) Field trip to Cologne zoo
Learning outcomes	Overview of worldwide mammal diversity (orders, major families) Overview of phylogeny and evolution of mammals. Introduction to the mammalian fossil record. Fundamental understanding of evolutionary processes enabling mammals to adapt to various environments.

2. Teaching and learning methods

	Type of instruction	Topic	Language of instruction	Group size	Weekly contact time*	Workload [h]
	V, S	Mammal Evolution	en.	40	4	150

3. Prerequisites for the module

compulsory	OEP-M1, OEP-M2
recommended	none

4. Degree program allocation

	Study program	compulsory/ elective	Semester
	MSc OEP-Biology	elective	2 o. 3

5. Requirements for the award of credits (ECTS)		6. Credits
Required achievements	none	**5**
Assessment (incl. weighting) and examination language	Written exam (100%), en.	

7. Frequency				8. Workload	9. Duration
Winter semester	☒	Winter and summer semester	☐	**150h**	**1 sem.**
Summer semester	☒				

Module coordination

Teacher	PD Dr. L. Podsiadlowski, Dr. E. Bärmann, Dr. J. Decher
Module coordinator	PD Dr. L. Podsiadlowski
Institute/Department	ZFMK/Biologie

Further information

(Reading lists, information links etc.)	Vaughan, T. A., J. M. Ryan, and N. J. Czaplewski. 2011. Mammalogy. Saunders College Publishing, Orlando. 755 pp. Kemp, T. S. 2005. The origin and evolution of mammals. Oxford

*SWS

Evolution of Mammals – Form and Function

OEP-B27

UNIVERSITÄT BONN

1. Content and intended learning outcomes

Content	Phylogeny and comparative anatomy of Mammals: Skull and skeleton morphology; Mammalian adaptations to different environments, e.g. variation of teeth adapted to feeding habits, modification of limbs due to running / flying /swimming Discussion of species concepts (theory and practice) Phylogenetic reconstruction: morphology and molecular data Critically interpreting primary publications (e.g. discussion of different phylogenetic hypotheses for the same taxa) Field trip to Cologne zoo
Learning outcomes	Overview of worldwide mammal diversity (orders, major families) Overview of phylogeny and evolution of mammals. Introduction to the mammalian fossil record. Fundamental understanding of evolutionary processes enabling mammals to adapt to various environments.

2. Teaching and learning methods

	Type of instruction	Topic	Language of instruction	Group size	Weekly contact time*	Workload [h]
	P, E	Comp. Morphology & Phylogenetics	en.	12	8	300

3. Prerequisites for the module

compulsory	none
recommended	none

4. Degree program allocation

	Study program	compulsory/ elective	Semester
	MSc OEP-Biology	elective	3

5. Requirements for the award of credits (ECTS)		6. Credits
Required achievements	Essay	**10**
Assessment (incl. weighting) and examination language	Written exam (30%), en. Written report (Protokoll) (55%), en. Oral presentation (Referat) (15%), en.	

7. Frequency				8. Workload	9. Duration
Winter semester	☒	Winter and summer semester	☐	**300h**	**1 sem.**
Summer semester	☐				

Module coordination

Teacher	PD Dr. L. Podsiadlowski, Dr. E. Bärmann, Dr. J. Decher
Module coordinator	PD Dr. L. Podsiadlowski
Institute/Department	ZFMK/Biologie

Further information

(Reading lists, information links etc.)	Vaughan, T. A., J. M. Ryan, and N. J. Czaplewski. 2011. Mammalogy. Saunders College Publishing, Orlando. 755 pp. Kemp, T. S. 2005. The origin and evolution of mammals. Oxford

*SWS

Experimental Behavioural Ecology

OEP-B28 INAKTIV

UNIVERSITÄT BONN

1. Content and intended learning outcomes

Content	Based on recent research papers presented by the students during the opening seminar, interesting research ideas will be critically discussed with the group and hypotheses are developed for experiments that can be conducted by the students within the course. Little experiments will be planned by the students. As experimental animals, sticklebacks, cichlids and gammarids are available. Numerous topics are offered including social behaviour (shoaling), inter- and intrasexual selection (mating behaviour), parasite-host-interactions (parasitic behavioral manipulation). In groups of 2 students, the experiments will be conducted, the data collected and statistically analysed (including advanced statistical methods using "R"). Experimental protocols will be prepared with special focus on experimental design and procedure and (graphical) presentation of the results. In the final seminar, the results will be presented by the students in form of a short talk or poster.
Learning outcomes	Behavioural Ecology explores the adaptive significance (the function) of behaviour in relation to the environment animals live in and interact with. It is deeply rooted in evolutionary theory and addresses a wide range of topics ranging from the evolution of social behaviour and group living (the evolution of altruism und cooperation), foraging, competitive behaviour, sexual selection and mate choice (including the evolution of conspicuous ornaments) and anti-predator strategies. The module gives an overview of the field of Behavioural Ecology but especially focuses on a hypothesis-driven experimental approach. Students will be introduced to the basics of experimental research: 1) development of scientific hypotheses, 2) creating appropriate experimental designs and set-ups, 3) conducting experiments under standardized conditions (including learning of different techniques to record animal behaviour), 4) collecting data and analyzing them (including advanced statistics), 5) writing a scientific protocol, 6) presenting the results as a talk or poster.

2. Teaching and learning methods

	Type of instruction	Topic	Language of instruction	Group size	Weekly contact time*	Workload [h]
	P	Exp. Behav. Ecol.	en.	6	6	240
	S	Exp. Behav. Ecol.	en.	6	2	60

3. Prerequisites for the module

compulsory	OEP-M1, OEP-M2
recommended	none

4. Degree program allocation

	Study program	compulsory/ elective	Semester
	MSc OEP-Biology	elective	2 o. 3

5. Requirements for the award of credits (ECTS)		6. Credits
Required achievements	Participation in a practical experiment	**10**
Assessment (incl. weighting) and examination language	Written report (Protokoll) (70%), en. Oral presentation (Präsentation) or poster presentation (30%)	

7. Frequency				8. Workload	9. Duration
Winter semester	☒	Winter and summer semester	☐	**300h**	**1 sem.**
Summer semester	☒				

Module coordination

Teacher	Dr. T. Thünken
Module coordinator	Dr. T. Thünken, N.N.
Institute/Department	IEZ/Biologie

Further information

(Reading lists, information links etc.)	Davies, N. B., Krebs, J. R. & West, S. A. (2012). An Introduction to Behavioural Ecology (4th ed.). Wiley-Blackwell, Oxford, UK

*SWS

Genomics of Behaviour

OEP-B29

UNIVERSITÄT BONN

1. Content and intended learning outcomes

Content	Based on recent scientific papers, students will present and discuss timely topics in behavioural genomics.
Learning outcomes	The seminar will provide background knowledge in connecting genomics and behavioural approaches. The students will gain insights in how to use these to shed light on the genomic fundamentals of behaviour in different groups of animals.

2. Teaching and learning methods

	Type of instruction	Topic	Language of instruction	Group size	Weekly contact time*	Workload [h]
	S	Genomics of Behaviour	en.	16	2	75

3. Prerequisites for the module

compulsory	OEP-M1, OEP-M2
recommended	none

4. Degree program allocation

	Study program	compulsory/ elective	Semester
	MSc OEP-Biology	elective	2 o. 3

5. Requirements for the award of credits (ECTS)		6. Credits
Required achievements	none	**2.5**
Assessment (incl. weighting) and examination language	Oral presentation (Referat) (100%)	

7. Frequency				8. Workload	9. Duration
Winter semester	☒	Winter and summer semester	☐	**75h**	**1 sem.**
Summer semester	☒				

Module coordination

Teacher	Dr. T. Thünken
Module coordinator	Dr. T. Thünken, N.N.
Institute/Department	IEZ/Biologie

Further information

(Reading lists, information links etc.)	will be announced

*SWS

Advanced Course in Combining Field and Lab Techniques and Methods in Organismic Biology, Evolutionary Biology and Paleobiology
OEP-B30

UNIVERSITÄT BONN

1. Content and intended learning outcomes	
Content	The module deals with specific topics in the laboratory and in the field of evolution, phylogenetics, biogeography or visualization of structures as well as for modeling evolutionary processes and the relationships between structure and function.
Learning outcomes	Proper design of field work for standardized data acquisition for advanced statistical analyses, modelling, visualization of structures, biodiversity and population analyses.

2. Teaching and learning methods	Type of instruction	Topic	Language of instruction	Group size	Weekly contact time*	Workload [h]
	P, E	as specified	en.	as specified	8	300

3. Prerequisites for the module	
compulsory	OEP-M1, OEP-M2
recommended	none

4. Degree program allocation	Study program	compulsory/ elective	Semester
	MSc OEP-Biology	elective	2 o. 3

5. Requirements for the award of credits (ECTS)		**6. Credits**
Required achievements	none	**10**
Assessment (incl. weighting) and examination language	Written report (Protokoll) (100%)	

7. Frequency				**8. Workload**	**9. Duration**
Winter semester	☒	Winter and summer semester	☐	**300h**	**1 sem.**
Summer semester	☒				

Module coordination	
Teacher	All teachers of the OEP-Biology program
Module coordinator	Prof. Dr. M. Weigend, Prof. Dr. T. Bartolomaeus
Institute/Department	Paläontologisches Institut, IEZ, Nees, IZ, IZMB, ZFMK

Further information	
(Reading lists, information links etc.)	will be announced

*SWS

Bee hotels as a model system for field ecology and insect interactions
OEP-B31

UNIVERSITÄT BONN

1. Content and intended learning outcomes

Content	In this module, students receive an exemplary introduction to ecological field studies: experiment design, data collection, analysis, and presentation – orally and in writing. On a technical level, the course focuses on classical entomology, palynology, and statistics. Hands-on data collection will be conducted in groups of 2-3 students. Students will analyse trap nests, identify insect orders, insect morphospecies and pollen from plants, and trap nests. Additionally, students record environmental data and statistically analyse possible interactions between the environment and insects/plants. At the end of the course, each group will discuss the results and present them to their fellow students in conventional academic formats: a mini-paper and a mini-conference with poster and oral presentation. The course is 6 hours per day, with independent work on data presentation.
Learning outcomes	Students acquire basic knowledge of the various disciplines of ecological sciences. The aim of the module is to provide students with an understanding of the complexity of animal-animal and animal-plant interactions caused by biotic and abiotic environmental conditions. Students will gain an understanding of ecological field studies by developing their own hypotheses about the effects of the environment on animal-animal and animal-plant interactions and then collecting raw data and cleaning them for statistical analysis. The students get to know the process of creating scientific publications by writing a mini-paper and presenting their results to their fellow students as a poster and orally.

2. Teaching and learning methods

	Type of instruction	Topic	Language of instruction	Group size	Weekly contact time*	Workload [h]
	P	Ecology	en.	12	8	300

3. Prerequisites for the module

compulsory	OEP-M1, OEP-M2
recommended	none

4. Degree program allocation

	Study program	compulsory/ elective	Semester
	MSc OEP-Biology	elective	3

5. Requirements for the award of credits (ECTS)		6. Credits
Required achievements	Participation research project, i.e. field-realistic study	**10**
Assessment (incl. weighting) and examination language	Oral presentation (33%), en. Poster presentation (33%), en. Written report/Minipaper (34%), en.	

7. Frequency				8. Workload	9. Duration
Winter semester	☒	Winter and summer semester	☐	**300h**	**1 sem.**
Summer semester	☐				

Module coordination

Teacher	Jun.-Prof. Dr. Antonia Mayr, Dr. Julia Gravendyck
Module coordinator	Jun.-Prof. Dr. Antonia Mayr
Institute/Department	IZ/Nees, Biologie

Further information

(Reading lists, information links etc.)

Beug, H. J. (2004). *Leitfaden der Pollenbestimmung für Mitteleuropa und angrenzende Gebiete*. Pfeil.

Gathmann A, Greiler H J, & Tscharntke T. (1994). Trap-nesting bees and wasps colonizing set-aside fields: Succession and body-size, management by cutting and sowing. Oecologia, 98, 8–14. https://doi.org/10.1007/bf00326084

Gathmann A, Tscharntke T. (1999). Landschafts-Bewertung mit Bienen und Wespen in Nisthilfen: Artenspektrum, Interaktionen und Bestimmungsschlüssel. Naturschutz und Landschaftspflege Baden-Württemberg, 73, 277-305.

Halbritter, H., Ulrich, S., Grímsson, F., Weber, M., Zetter, R., Hesse, M., Buchner, R., Svojtka, M., & Frosch-Radivo, A. (2018). Illustrated Pollen Terminology. In *Illustrated Pollen Terminology* (Second Edi). Springer International Publishing. https://doi.org/10.1007/978-3-319-71365-6

Staab M, Pufal G, Tscharntke T, Klein A-M (2018). Trap nests for bees and wasps to analyse trophic interactions in changing environments—A systematic overview and user guide. Methods Ecol Evol, 00, 1–14. https://doi.org/10.1111/2041-210X.13070

Elective modules

Elective area C

Modules with more than 50% fieldwork

Marine Biology

OEP-C01

UNIVERSITÄT BONN

1. Content and intended learning outcomes

Content	During the field course students will observe marine organisms in situ. The course comprises analyses of identification of marine invertebrates, as well as studying life animals in their natural habitat and their ecological adaptations according to their environment. Selected species will be identified and systematics as well as ecological traits elaborated. Anatomical studies will be performed especially for those species, where this is necessary for identification or where special morphological adaptations will be demonstrated. During the seminar, life traits of selected species will be presented.
Learning outcomes	During a field study, students will achieve a good knowledge on functional morphology, ecological traits and constraints in selected marine habitats. They will learn to recognize special adaptations (morphologically or physiologically based) as a necessity for the organism to survive in these special habitats. By anatomical preparation, special skills in preparation and identification of marine invertebrates will be achieved. Drawing and presentation skills will be trained. Different methods for working in marine environments will be trained. (Sampling techniques under water, conserving, monitoring, experiments with marine life animals).

2. Teaching and learning methods

	Type of instruction	Topic	Language of instruction	Group size	Weekly contact time*	Workload [h]
	S	Marine biology of selected species	en.	10	2	60
	P, E	Biology & ecology of marine invertebrates	en.	10	6	240

3. Prerequisites for the module

compulsory	OEP-M1, OEP-M2
recommended	none

4. Degree program allocation

	Study program	compulsory/ elective	Semester
	MSc OEP-Biology	elective	2 o. 3
	MSc Plant Sciences	elective	2 o. 3

5. Requirements for the award of credits (ECTS)		6. Credits
Required achievements	Oral presentation (Referat) Scientific exposé (data sheets)	**10**
Assessment (incl. weighting) and examination language	Written exam (100%)	

7. Frequency				8. Workload	9. Duration
Winter semester	☒	Winter and summer semester	☐	**300h**	**1 sem.**
Summer semester	☒				

Module coordination

Teacher	Prof. Dr. H. Wägele
Module coordinator	Prof. Dr. H. Wägele
Institute/Department	ZFMK/Biologie

Further information

(Reading lists, information links etc.)	Tardent, Meeresbiologie, Thieme Verlag Westheide, Rieder: Spezielle Zoologie Kästner, Lehrbuch der Speziellen Zoologie Sommer U. Biologische Meereskunde. Springer Verlag Hofrichter: Das Mittelmeer Band I und II Englische Spezialliteratur

*SWS

Zoogeography and Ecology of Marine Organisms in Tropical Habitats with Excursion to the Red Sea
OEP-C02

UNIVERSITÄT BONN

1. Content and intended learning outcomes

Content	Aim of the excursion is an introduction to the fauna of tropical coral reefs. For this purpose a qualitative assessment of the diverse invertebrates and vertebrates is to be conducted as well as a determination of the present species composition with the help of photographs and identification keys (establishment of a species catalogue). Furthermore a comparison of feeding and social behaviours in different fish species will be conducted based on direct observations. Abiotic parameters (e.g. temperature, salinity) in different reef habitats will be measured and compared. The opportunity for some dives is given. Condition for participants: Excellent abilities in swimming and snorkeling
Learning outcomes	

2. Teaching and learning methods

	Type of instruction	Topic	Language of instruction	Group size	Weekly contact time*	Workload [h]
	V	Marine organisms in tropical habitats	en.	12	1	30
	S	Marine organisms in tropical habitats	en.	12	1	60
	P, E	Marine organisms in tropical habitats	en.	12	6	210

3. Prerequisites for the module

compulsory	OEP-M2
recommended	none

4. Degree program allocation

	Study program	compulsory/ elective	Semester
	MSc OEP-Biology	elective	2 o. 3

5. Requirements for the award of credits (ECTS)		6. Credits
Required achievements		**10**
Assessment (incl. weighting) and examination language	Written report (Protokoll) (50%) Oral presentation (Referat) (50%)	

7. Frequency				8. Workload	9. Duration
Winter semester	☒	Winter and summer semester	☐	**300h**	**1 sem.**
Summer semester	☒				

Module coordination

Teacher	Prof. Dr. H. Bleckmann, Dr. D. Rödder
Module coordinator	Prof. Dr. H. Bleckmann, Dr. D. Rödder
Institute/Department	ZFMK/Biologie

Further information

(Reading lists, information links etc.)	will be announced before start of course

*SWS

Ecology of the Wadden Sea

OEP-C03

UNIVERSITÄT BONN

1. Content and intended learning outcomes

Content	The course addresses students with an interest in marine biology and provides an opportunity to get in contact with the scientific staff of the Wadden Sea Station List auf Sylt or at the AWI. The module imparts knowledge of the fauna of the North Sea tidal flats and introduces students to experimental Wadden Sea ecology. Students design and independently conduct experiments on the fauna's reaction to disturbances, studies on the biology of organisms, and habitat-specific diversity patterns. In the lecture and seminar part, basic knowledge about planning, execution, and analysis of haypotheses driven field experiments in the Wadden Sea will be taught. The lecture also introduces the geology, biology and abiotic parameters of this unique UNESCO World Natural Heritage. Special emphasis is placed on the anthropogenic changes of this habitat and the influence of neozoans. The lecture will be held in Bonn, prior to the practical part; the seminar on the island of Sylt. The module will be held in cooperation with the University of Bielefeld at the Alfred Wegener Institute in List auf Sylt. Therefore, the teaching language is German. There are 8 places available.
Learning outcomes	Understanding of the Wadden Sea as ecosystem, knowledge of physical conditions governing the tidal zone, interaction of tidal organisms, faunistics, statistical methods and experimental design in the field.

2. Teaching and learning methods

	Type of instruction	Topic	Language of instruction	Group size	Weekly contact time*	Workload [h]
	V	Ecology of the Wadden Sea	en.	12	1	30
	S	Ecology of the Wadden Sea	en.	12	1	30
	P, E	Ecology of the Wadden Sea	en.	12	3	90

3. Prerequisites for the module

compulsory	OEP-M1, OEP-M2
recommended	none

4. Degree program allocation

	Study program	compulsory/ elective	Semester
	MSc OEP-Biology	elective	2 o. 3

5. Requirements for the award of credits (ECTS)		6. Credits
Required achievements	Oral presentations (Präsentationen)	**5**
Assessment (incl. weighting) and examination language	Written report (Protokoll) (100%)	

7. Frequency			8. Workload	9. Duration
Winter semester	☒	Winter and summer semester ☐	**150h**	**1 sem.**
Summer semester	☒			

Module coordination

Teacher	Dr. J. von Döhren
Module coordinator	Prof. Dr. T. Bartolomaeus
Institute/Department	IEZ/Biologie

Further information

(Reading lists, information links etc.)	Rafelli & Hawkins (1996) Intertidal ecology. Springer Original papers will be provided on ecampus

*SWS

Biodiversity and Ecological Constraints on the Rocky shore
OEP-C04

UNIVERSITÄT BONN

1. Content and intended learning outcomes

Content	The module addresses the role of environmental constraints on the life history, distribution, interaction and diversity of marine organisms in the rocky shoe of Brittany (France). The module introduces into the fauna of the rocky shore teaches how to design, conduct and statistically analyze field experiments. The students will give presentations of recent topics of marine biology; most topics are related to the experiments that have to be designed by the students. Students will also give presentations of selected intertidal organisms. At the end of the module they have to present and defend their experiments and results. The entire module will be held at the Laboratoire de Biology Marine of the Musem National d'Histoire Naturelle (Paris) in Concarneau.
Learning outcomes	Knowledge of intertidal ecology of rocky shores, functional constraints on intertidal organisms and their responses, knowledge of physical conditions governing the tidal zone, interaction of tidal organisms, faunistics, statistical methods and design of hypotheses driven field experiments.

2. Teaching and learning methods

	Type of instruction	Topic	Language of instruction	Group size	Weekly contact time*	Workload [h]
	V	Marine Ecology	en. (see below	20	2	60
	S	Marine and intertidal ecology	en. (see below)	14	1	60
	P, E	Biodiv. and Ecol. Constraints on the Rocky Shore	en. (see below)	14	7	180

3. Prerequisites for the module

compulsory	OEP-M1, OEP-M2
recommended	

4. Degree program allocation

	Study program	compulsory/ elective	Semester
	MSc OEP-Biology	elective	2 o. 3

5. Requirements for the award of credits (ECTS)		6. Credits
Required achievements	Oral presentations (Präsentationen)	**10**
Assessment (incl. weighting) and examination language	Written report (Protokoll) (100%)	

7. Frequency				8. Workload	9. Duration
Winter semester	☒	Winter and summer semester	☐	**300h**	**1 sem.**
Summer semester	☒				

Module coordination

Teacher	Dr. J. von Döhren, Dr. E. Tilic
Module coordinator	Prof. Dr. T. Bartolomaeus
Institute/Department	IEZ/Biologie

Further information

(Reading lists, information links etc.)	The module will be held in German every second year Rafelli & Hawkins (1996) Intertidal ecology. Springer Little, Williams Trowbridge (2009) The biology rocky shore. Oxford University Press Original papers will be provided on ecampus

*SWS

Fauna of the North-Atlantic Coast Line
with a Field Trip to Roscoff/Bretagne
OEP-C05

UNIVERSITÄT BONN

1. Content and intended learning outcomes

Content	The module consists of an introductory seminar with practicals on the identification of marine animals, a two-week exkursion to Roscoff/Bretagne and a final week of post-processing in Bonn. In the first week of the module the students will prepare themselves for the ensuing excursion by giving oral presentations on selected topics of marine biology, on selected animal groups, and by identifying species with identification keys. Each student is expected to specialize on a specific animal group. During the two-week excursion, we will be accomodated at the reknown Marine Biology Station in Roscoff where we will also have a well-equipped classroom at our disposal. From there, we will conduct almost daily trips to diverse nearby locations along the coast, e.g. the Island of Batz, investigate fauna and ecology of cliff, sand and mud flats and salt marshes. An integral part of the excursion is a boat trip with the station's own boat, the „Neomysis", to take samples from the ocean floor with a trawling net. Finally, we will go for a short hike to the hilly country in the central Bretagne, the „Monts d'Arrée". There will also be time to visit a few cultural landmarks of the Bretagne. On our daytrips, we will collect animals, bring them back to the Station where we will cultivate, inestigate and indentify them during the late afternonn and evening in our classroom. The majority of marine animals are invertebrates and therefore will comprise most of our collections. However, there will also be the possibility to study fish collected from tidal pools and of course we will observe many shore birds. In addition to the daily routines, students are expected to conduct small quantitative experiments. These include for instance the demonstration of fertilization and subsequent development of sea urchin eggs, a systematic analysis of tidal pools at different locations in the litoral, an experiment on location fidelity of limpets and other snails, a quantitative survey of the polychaete fauna and a study on the radula length of limpets. After our return to Bonn, the final week of the module serves to prepare and finalize individual day protocols, additional protocols on the small experiments and to put together the final group protocol.
Learning outcomes	The north-atlantic coastline of France offers diverse habitats including cliff, sand, and mud flats („Watt"). In this module, students will get to know the fauna of these habitats and will be trained in the understanding of the relationship between biodiversity and environmental conditions. In addition, methods will be taught on how to obtain free field data and to determine animals with the help of identification keys.

2. Teaching and learning methods

	Type of instruction	Topic	Language of instruction	Group size	Weekly contact time*	Workload [h]
	S	Marine Fauna	de./en.	6	2	30
	V	Marine Fauna	de./en.	6	1	30
	E, P	Marine Fauna	de./en.	6	7	240

3. Prerequisites for the module

compulsory	OEP-M1, OEP-M2
recommended	

4. Degree program allocation

	Study program	compulsory/ elective	Semester
	MSc OEP-Biology	elective	2 o. 3

5. Requirements for the award of credits (ECTS) / 6. Credits

Required achievements	1-2 single day reports one additional report on a quantitative experiment group report composed of day protocols and additional reports	**10**
Assessment (incl. weighting) and examination language	Written exam (50%) Oral presentation (Präsentation) (50%)	

7. Frequency				8. Workload	9. Duration
Winter semester	☒	Winter and summer semester	☐	**300h**	**1 sem.**
Summer semester	☒				

Module coordination

Teacher	PD Dr. J. Mogdans
Module coordinator	PD Dr. J. Mogdans
Institute/Department	IZ/Biologie

Further information

(Reading lists, information links etc.)	Sommer U (2005) Biologische Meereskunde. 2. Aufl., Springer Verlag, Tardent P (2006) Meeresbiologie. 3. Aufl., Thieme Verlag, Westheide W, Rieger RM (2006) Spezielle Zoologie, Bd.1, Spektrum Verlag, Brohmer P, Schaefer M (2000) Fauna von Deutschland. Quelle & Meyer Verlag, Hayward PJ, Ryland JS (2008) Handbook of the Marine Fauna of North-West Europe. Oxford University Press The latter two books will be provided for each student.

*SWS

Ecology and Zoogeography of the Pannonian Area, with a Field Trip to the Neusiedler Lake
OEP-C06

UNIVERSITÄT BONN

1. Content and intended learning outcomes	
Content	The field trip to the Neusiedlersee area provides insight into the ecological and biogeographic peculiarities of the Pannonian area, also in comparison to the nearby Eastern Alps. Comparisons will also be made with habitats in central Hungary which will help to understand the interconnection between central and peripheral areas. Knowledge in metazoan taxa will be broadened and taxonomic studies performed.
Learning outcomes	Students will learn about subjects of ecology and zoogeography, in particular of the Pannonian area.

2. Teaching and learning methods

	Type of instruction	Topic	Language of instruction	Group size	Weekly contact time*	Workload [h]
	V	Ecol. & Zoogeogr. of the Pannonian area	en.	15	1	60
	S	Ecol. & Zoogeogr. of the Pannonian area	en.	15	1	60
	E, P	Ecol. & Zoogeogr. of the Pannonian area	en.	15	6	180

3. Prerequisites for the module	
compulsory	OEP-M2
recommended	

4. Degree program allocation

	Study program	compulsory/ elective	Semester
	MSc OEP-Biology	elective	2 o. 3

5. Requirements for the award of credits (ECTS)		**6. Credits**
Required achievements	Written report (Protokoll)	**10**
Assessment (incl. weighting) and examination language	Oral presentation (Referat) (100%)	

7. Frequency				**8. Workload**	**9. Duration**
Winter semester	☒	Winter and summer semester	☐	**300h**	**1 sem.**
Summer semester	☒				

Module coordination	
Teacher	Dr. D. Rödder, Dr. C. Koch
Module coordinator	Dr. D. Rödder, Dr. C. Koch
Institute/Department	ZFMK/Biologie
Further information	
(Reading lists, information links etc.)	will be announced before start of course.

*SWS

Biodiversity of the Tropics, with a Field Trip to Ecuador

OEP-C07

UNIVERSITÄT BONN

1. Content and intended learning outcomes

Content	After a preparation seminar in which the basics of tropical ecology will be taught in several lectures the field trip to the tropical rainforest and Páramo habitats in Ecuador will provide insights into the ecological and biogeographic peculiarities of these ecoregions. Knowledge in metazoan taxa will be broadened and taxonomic studies performed. The practical exercises take place in the laboratory and in the field. During the course students will improve their ability to critically discuss current literature and to prepare scientific presentations. Students will learn to discover and catch animals, to observe their life style and to study the morphology of selected species.
Learning outcomes	Students will get an overview about the particularities of the tropics. They will gain deeper insight into the taxonomy and ecology of selected metazoan groups and acquire skills in the identification of vertebrate and invertebrate species. The adaptations to different habitats as well as behavior and life cycle characteristics of different species will be investigated. The causes and consequences of current environmental threats (e.g. habitat loss, pollution) will be elaborated with the students. Furthermore relevant methods for field work will be trained.

2. Teaching and learning methods

	Type of instruction	Topic	Language of instruction	Group size	Weekly contact time*	Workload [h]
	S	Biodiversity of the Tropics	en.	13	2	60
	E, P	Biodiversity of the Tropics	en.	13	8	240

3. Prerequisites for the module

compulsory	OEP-M1, OEP-M2
recommended	

4. Degree program allocation

	Study program	compulsory/ elective	Semester
	MSc OEP-Biology	elective	2 o. 3

5. Requirements for the award of credits (ECTS)		6. Credits
Required achievements	None	**10**
Assessment (incl. weighting) and examination language	Oral presentation (Referat) (50%) Written report (Protokoll) (50%)	

7. Frequency				8. Workload	9. Duration
Winter semester	☒	Winter and summer semester	☐	**300h**	**1 sem.**
Summer semester	☒				

Module coordination

Teacher	Dr. C. Koch, Dr. X. Mengual, R. Wistuba
Module coordinator	Dr. C. Koch
Institute/Department	ZFMK/Biologie

Further information

(Reading lists, information links etc.)	will be announced before start of course.

*SWS

Behavioural Ecology of Birds

OEP-C08

UNIVERSITÄT BONN

1. Content and intended learning outcomes

Content	The fieldwork of the course will take place for 3 weeks, from the beginning of May, in a tent camp in a mixed woodland area near Wolfsburg / Lower Saxony. After a general introduction into avian field work, banding and handling of small passerines, we will try to answer a simple behavioural question with practical experiments. These experiments will be conducted in groups of two and each participant has the chance to gain experience in both major fields of bird observation and manipulation. The last but not least important week the course will take place at the institute's computer lab and lecture room. The results of the observations and experimental treatments are statistically analysed and presented in a written protocol in form of a thesis (rationale, methods, results, and conclusion) and short presentations of the results are given to the comrade students.
Learning outcomes	The aim of this course is to develop theoretical, organizational and practical skills to transfer proximate and ultimate questions in the field of Behavioural Ecology into scientific hypotheses, to test these hypotheses in practical field experiments, to analyse the results and to give answers to the initial questions. You will learn how to use hole-breeding passerine birds as a model organism for behavioural ecological studies, their handling, the difficulties and the advantages of working with free-living organisms. Further on you will learn about the difficulties of practically experimental design, the statistical analyses of the results, and the formulation of answers in form of a written protocol. Last, but not least the experience of a self managed field camp will give a basic training in capacity for teamwork and social skills.

2. Teaching and learning methods

	Type of instruction	Topic	Language of instruction	Group size	Weekly contact time*	Workload [h]
	E, P	Behavioural Ecology of Birds	en.	6	10	300

3. Prerequisites for the module

compulsory	OEP-M1, OEP-M2, OEP-B04
recommended	

4. Degree program allocation

	Study program	compulsory/ elective	Semester
	MSc OEP-Biology	elective	2 o. 3

5. Requirements for the award of credits (ECTS)		6. Credits
Required achievements	None	**10**
Assessment (incl. weighting) and examination language	Written report (Protokoll) (100%)	

7. Frequency				8. Workload	9. Duration
Winter semester	☒	Winter and summer semester	☐	**300h**	**1 sem.**
Summer semester	☒				

Module coordination

Teacher	Dr. J. Brün
Module coordinator	Prof. Dr. T. Lubjuhn
Institute/Department	IEZ/Biologie

Further information

(Reading lists, information links etc.)	Davies, N.B., Krebs, J.R., West, S.A. (2012) An Introduction to Behavioural Ecology. Wiley-Blackwell Gosler, A. (1993) Hamlyn Species Guides - The Great Tit. Reed International Books Ltd., London

*SWS

Vegetation Ecology (including Excursion) **OEP-C09/PBEC**	UNIVERSITÄT BONN

1. Content and intended learning outcomes	
Content	The course deals with the field of vegetation ecology and field biology. This includes field work and related work in the lab, the herbarium, and computer software to study the structure and floristic composition of plant communities. The field work includes one large (up to 3 weeks) or several small field trips.
Learning outcomes	The students will learn methods of inventorying, identifying, and studying plants and vegetation types in relation to ecological factors. They should gain insight in the field work as well as related work in the herbarium and data analyses.

2. Teaching and learning methods						
	Type of instruction	Topic	Language of instruction	Group size	Weekly contact time*	Workload [h]
	Ü, S, E	Vegetation Ecology	en.	15	8 (4)	300 (150)

3. Prerequisites for the module	
compulsory	OEP-M1, OEP-M2
recommended	

4. Degree program allocation			
	Study program	compulsory/ elective	Semester
	MSc OEP-Biology	elective	2 o. 3
	MSc Plant Sciences	elective	2 o. 3

5. Requirements for the award of credits (ECTS)		**6. Credits**
Required achievements	None	**10 (5)**
Assessment (incl. weighting) and examination language	Oral presentation (Referat) and/or poster presentation (50%) Written report (Protokoll) (50%)	

7. Frequency				**8. Workload**	**9. Duration**
Winter semester	☒	Winter and summer semester	☐	**300h (150h)**	**1 sem.**
Summer semester	☒				

Module coordination	
Teacher	Dr. C. Löhne, Dr. J. Mutke, Prof. Dr. D. Quandt, Prof. Dr. M. Weigend
Module coordinator	Prof. Dr. D. Quandt, Prof. Dr. M. Weigend
Institute/Department	Nees-Institut/Biologie

Further information	
(Reading lists, information links etc.)	The course deals with the field of vegetation ecology and field biology. This includes field work and related work in the lab, the herbarium, and computer software to study the structure and floristic composition of plant communities. **The field work includes one large (up to 3 weeks) (10CP) or optionally several small field trips (5CP).**

*SWS

Palaeontology and Biology of Texas – An Integrated Field Course **OEP-C10** **INAKTIV**	UNIVERSITÄT BONN

1. Content and intended learning outcomes	
Content	
Learning outcomes	

2. Teaching and learning methods	Type of instruction	Topic	Language of instruction	Group size	Weekly contact time*	Workload [h]
	S	Palaeontology & Biology of Texas	en.	40	2	60
	E	Palaeontology & Biology of Texas	en.	40	6	240

3. Prerequisites for the module	
compulsory	OEP-M1, OEP-M2
recommended	

4. Degree program allocation	Study program	compulsory/ elective	Semester
	MSc OEP-Biology	elective	2 o. 3

5. Requirements for the award of credits (ECTS)		**6. Credits**
Required achievements	None	**10**
Assessment (incl. weighting) and examination language	Oral presentation (Referat) (30%) Written report (Protokoll) (70%)	

7. Frequency				**8. Workload**	**9. Duration**
Winter semester	☒	Winter and summer semester	☐	**300h**	**1 sem.**
Summer semester	☒				

Module coordination	
Teacher	PD Dr. C. Gee
Module coordinator	PD Dr. C. Gee
Institute/Department	Paläontologisches Institut/Geowissenschaften

Further information	
(Reading lists, information links etc.)	The course deals with the field of vegetation ecology and field biology. This includes field work and related work in the lab, the herbarium, and computer software to study the structure and floristic composition of plant communities. The field work includes one large (up to 3 weeks) or several small field trips.

*SWS

Mesozoic Dinosaur and Plant Ecosystems and the Marine Realm in a Transect from southern Germany to northern Italy

OEP-C11 **INAKTIV**

UNIVERSITÄT BONN

1. Content and intended learning outcomes

Content	The following seminar topics and field trip stops are slated: Early Permian Rotliegend flora and fauna, the Permian/Triassic boundary flora and fauna in the southern Tyrol, Triassic reef formation in the Dolomites, Early Triassic Buntsandstein flora, Middle-Late Triassic marine vertebrate and invertebrate faunas, Triassic and Jurassic dinosaur trackways in Switzerland, Early Jurassic marine fauna of Holzmaden, Late Jurassic terrestrial ecosystems (plants and dinosaurs) of North America, Late Jurassic lagoonal biota of Solnhofen, Middle Eocene lagoonal fauna, Pleistocene-Holocene glacial geology and biota.
Learning outcomes	The objective of this module is to give biology students a basic understanding of paleontology and geology. The weekly seminar from April to July in Summer Semester and the 3-week field course in July-August are especially designed with OEP Biology students in mind as an introduction to paleontological field methods. In seminar, we will focus primarily on Mesozoic localities with fossil plants and on terrestrial and marine vertebrates north and south of the Alps, although we will also dip into the Permian and reach up into the Eocene and Pleistocene. The field trip will include stops at active excavations, discussion of fossil organisms and their geological context, and visits to classical fossil floras and faunas in the field and in museums in the Alsace, southern Germany, Switzerland, and northern Italy.

2. Teaching and learning methods

	Type of instruction	Topic	Language of instruction	Group size	Weekly contact time*	Workload [h]
	S	Mesozoic Dinosaur & Plant Ecosystems (Italy)	en.	25	2	60
	E	Mesozoic Dinosaur & Plant Ecosystems (Italy)	en.	25	6	240

3. Prerequisites for the module

compulsory	OEP-M1, OEP-M2
recommended	

4. Degree program allocation

	Study program	compulsory/ elective	Semester
	MSc OEP-Biology	elective	2 o. 3

5. Requirements for the award of credits (ECTS)		6. Credits
Required achievements	None	**10**
Assessment (incl. weighting) and examination language	Oral presentation (Referat) (30%) Written report (Protokoll) (70%)	

7. Frequency				8. Workload	9. Duration
Winter semester	☒	Winter and summer semester	☐	**300h**	**1 sem.**
Summer semester	☒				

Module coordination

Teacher	PD Dr. C. Gee
Module coordinator	PD Dr. C. Gee
Institute/Department	Paläontologisches Institut/Geowissenschaften

Further information

(Reading lists, information links etc.)	Students will consult individually with an instructor about recommended reading and topics in preparation for their seminar presentations.

*SWS

Mesozoic Dinosaur and Plant Ecosystems and the Marine Realm in England
OEP-C12 **INAKTIV**

UNIVERSITÄT BONN

1. Content and intended learning outcomes

Content	Slated are the following field trip stops and topics: - Upper Triassic vertebrate fauna at Aust Cliff - Jurassic marine invertebrate & vertebrate faunas along the South Coast of England - Lower Jurassic marine invertebrates and vertebrates of Yorkshire - Middle Jurassic terrestrial plant community of Yorkshire - Middle Jurassic marine invertebrate and vertebrates at Peterborough - Upper Jurassic "fossil forest" at Lulworth Cove - Lower Cretaceous dinosaur & plant assemblages on the Isle of Wight - Upper Cretaceous chalk cliffs of Dover - Natural History Museum in London - Historic dinosaur sculptures at the Crystal Palace grounds in London - Living Mesozoic flora at Royal Botanic Gardens Kew - Darwin's residence and place of work at Down House A prerequisite for the field course is participation in the preparatory seminar course which, like the field trip, will be conducted in English.
Learning outcomes	The objective of this module is to give biology students a basic understanding of paleontology and geology through a two-week, hands-on field trip to Mesozoic fossil localities, museums, and other sites of paleontological importance in England. This is primarily a field course, with most teaching occurring on-site, although a mandatory, two-day block seminar will provide students in advance with the basic geology and paleontology necessary for the field trip.

2. Teaching and learning methods

	Type of instruction	Topic	Language of instruction	Group size	Weekly contact time*	Workload [h]
	S	Mesozoic Dinosaur & Plant Ecosyst. (Engl)	en.	20	2	60
	E	Mesozoic Dinosaur & Plant Ecosyst. (Engl.)	en.	20	6	240

3. Prerequisites for the module

compulsory	OEP-M1, OEP-M2
recommended	

4. Degree program allocation

	Study program	compulsory/ elective	Semester
	MSc OEP-Biology	elective	2 o. 3

5. Requirements for the award of credits (ECTS)		6. Credits
Required achievements	None	**10**
Assessment (incl. weighting) and examination language	Oral presentation (Referat) (30%) Written report (Protokoll) (70%)	

7. Frequency				8. Workload	9. Duration
Winter semester	☒	Winter and summer semester	☐	**300h**	**1 sem.**
Summer semester	☒				

Module coordination

Teacher	PD Dr. C. Gee
Module coordinator	PD Dr. C. Gee
Institute/Department	Paläontologisches Institut/Geowissenschaften

Further information

(Reading lists, information links etc.)	Any recommended reading will be provided to the students by the instructors.

*SWS

Integrated Field Course Brazil

OEP-C13 INAKTIV

UNIVERSITÄT BONN

1. Content and intended learning outcomes	
Content	This module consists of a preparatory seminar and a 12-day field trip to Brazil. The trip will cover important paleontological localities and representative habitats of Brazil.
Learning outcomes	Familiarizing yourself with the environment and biota through geologic time of a selected region.

2. Teaching and learning methods

	Type of instruction	Topic	Language of instruction	Group size	Weekly contact time*	Workload [h]
	S	Integrated Field Course Brazil	en.	18	2	60
	E	Integrated Field Course Brazil	en.	18	6	240

3. Prerequisites for the module

compulsory	OEP-M1, OEP-M2
recommended	

4. Degree program allocation

	Study program	compulsory/ elective	Semester
	MSc OEP-Biology	elective	2 o. 3

5. Requirements for the award of credits (ECTS)		6. Credits
Required achievements	None	**10**
Assessment (incl. weighting) and examination language	Oral presentation (Referat) (30%) Written report (Protokoll) (70%)	

7. Frequency				8. Workload	9. Duration
Winter semester	☒	Winter and summer semester	☐	**300h**	**1 sem.**
Summer semester	☒				

Module coordination	
Teacher	N.N.
Module coordinator	N.N.
Institute/Department	Paläontologisches Institut/Geowissenschaften

Further information	
(Reading lists, information links etc.)	

*SWS

Evolution and Biology of Amphibians: The Fossil Record

OEP-C14

UNIVERSITÄT BONN

1. Content and intended learning outcomes

Content	We will introduce major fossil groups such as stem tetrapods like Acanthostega, Ichthyostega, Whatcheeriiae or Bapheidea, Temnospondyli and Lepospondyli; discuss their morphology and phylogenetic relationships. Other topics are the invasion of land by tetrapods and the origin of Lissamphibia. Growth and life style are major traits that can be deduced from bone histological analyses. Methods, thus, include morphology, phylogeny and bone histology. Practical field work in form of a scientific excavation will be taught during a 7-day field trip to Krasiejów, SW Poland.
Learning outcomes	The participants will gain insights into evolution and paleobiology of extinct amphibians. Amphibia had been incredibly diverse in the past, with groups resembling modern crocodile in size and life style and miniature forms on the other side. We will lecture about their origin, their fossil record, and phylogenetic relationships within tetrapods as well as about phylogenetic relationships of the different groups. Paleobiology and life styles of these extinct forms will also be in the focus.

2. Teaching and learning methods

	Type of instruction	Topic	Language of instruction	Group size	Weekly contact time*	Workload [h]
	V, S	Evolution and Biology of Amphibians: The Fossil Record	en.	15	3	90
	prÜ, E	Evolution and Biology of Amphibians: The Fossil Record	en.	15	2	60

3. Prerequisites for the module

compulsory	
recommended	

4. Degree program allocation

	Study program	compulsory/ elective	Semester
	MSc OEP-Biology	elective	2 o. 3

5. Requirements for the award of credits (ECTS)		6. Credits
Required achievements	Five scientific exposés (data sheets)	**5**
Assessment (incl. weighting) and examination language	Oral presentation (Referat) (50%) Written report (Protokoll) (50%)	

7. Frequency				8. Workload	9. Duration
Winter semester	☒	Winter and summer semester	☐	**150h**	**1 sem.**
Summer semester	☒				

Module coordination

Teacher	Dr. N. Klein, Dr. D. Konietzko-Meier
Module coordinator	Dr. N. Klein, Dr. D. Konietzko-Meier
Institute/Department	Paläontologisches Institut/Geowissenschaften

Further information

(Reading lists, information links etc.)	

*SWS

Paleontology and Biology of the Bighorn Basin, Wyoming, USA **OEP-C15**	UNIVERSITÄT BONN

1. Content and intended learning outcomes	
Content	In the weekly seminar, students will read and discuss scientific papers necessary to the understanding of the Paleogene fauna and flora and to the PETM. Fieldwork will consist of digging fossil vertebrates and plants, as well as other geological and paleontological fieldwork. The preparatory weekly seminar is mandatory for the 2-week stay in the field and will be conducted in English.
Learning outcomes	The objective of this module is to give biology students a basic introduction into paleontological field methods through the excavation of Eocene plants and mammals in the Bighorn Basin of northern Wyoming. The semi-arid scrubland of the basin and the coniferous forest of the adjacent Bighorn Mountains also provide a diversity of wildlife and natural habitats for biological field study.

2. Teaching and learning methods

	Type of instruction	Topic	Language of instruction	Group size	Weekly contact time*	Workload [h]
	S	Paleontology and Biology of the Bighorn Basin	en.	16	2	60
	E	Paleontology and Biology of the Bighorn Basin	en.	8	6	240

3. Prerequisites for the module	
compulsory	OEP-M1, OEP-M2
recommended	

4. Degree program allocation

	Study program	compulsory/ elective	Semester
	OEP-Biology	elective	2 o. 3

5. Requirements for the award of credits (ECTS)		**6. Credits**
Required achievements	None	**10**
Assessment (incl. weighting) and examination language	Oral presentation (Referat) (30%) Written report (Protokoll) (70%)	

7. Frequency				**8. Workload**	**9. Duration**
Winter semester	☒	Winter and summer semester	☐	**300h**	**1 sem.**
Summer semester	☒				

Module coordination	
Teacher	PD Dr. C. Gee, Prof. Dr. M. Weigend
Module coordinator	PD Dr. C. Gee, Prof. Dr. M. Weigend
Institute/Department	Paläontologisches Institut/Geowissenschaften, Nees-Institut/Biologie
Further information	
(Reading lists, information links etc.)	Frequency of module: all 3-4 years

*SWS

Advanced Field Methods in Organismic Biology, Evolutionary Biology and Paleobiology
OEP-C16

UNIVERSITÄT BONN

1. Content and intended learning outcomes	
Content	The module deals with specific topics in the field of paleontology, phylogenetics, biogeography, monitoring, and the relationship between organism and environment. The aim of the course is to acquire skills for field work. The module may include laboratory components, which must be less than 50% of the invested time.
Learning outcomes	Proper design of field work for standardized data acquisition for advanced statistical analyses, modelling, visualization of structures, biodiversity and population analyses.

2. Teaching and learning methods	Type of instruction	Topic	Language of instruction	Group size	Weekly contact time*	Workload [h]
	P, E	as specified	en.	as specified	8	300

3. Prerequisites for the module	
compulsory	OEP-M1, OEP-M2
recommended	

4. Degree program allocation	Study program	compulsory/ elective	Semester
	MSc OEP-Biology	elective	2 o. 3

5. Requirements for the award of credits (ECTS)		**6. Credits**
Required achievements	None	**10**
Assessment (incl. weighting) and examination language	Written report (Protokoll) (100%)	

7. Frequency				**8. Workload**	**9. Duration**
Winter semester	☒	Winter and summer semester	☐	**300h**	**1 sem.**
Summer semester	☒				

Module coordination	
Teacher	All teachers of the OEP-Biology master program
Module coordinator	Prof. Dr. M. Weigend, Prof. Dr. T. Bartolomaeus
Institute/Department	Paläontologisches Institut, IEZ, Nees, IZ, IZMB, ZFMK

Further information	
(Reading lists, information links etc.)	will be announced

*SWS

Animal ecology and methods in biodiversity monitoring

OEP-C17

UNIVERSITÄT BONN

1. Content and intended learning outcomes

Content	The course consists of two parts: (a) a lecture introducing important concepts in animal ecology and (b) a field course on biodiversity monitoring. In the lecture, aspects of animal ecology are covered that are important to understand biodiversity change. The lecture starts with responses of individual species to environmental change (autecology), moving on to populations (population ecology), communities, ecosystems and biodiversity, ending with global environmental problems such as land-use and climate change. In the field course, methods in biodiversity monitoring are introduced with a focus on vertebrates and invertebrates. Starting with how to plan and design a field study, the course involves methods to measure animal abundance, camera-based monitoring, invertebrate sampling methods, and estimating resource use, ecosystem processes and multitrophic interactions, including basics of data collection and analysis.
Learning outcomes	The students know and apply important concepts in animal ecology. They are able to plan and design an own field study and develop sampling and analysis strategies in biodiversity monitoring.

2. Teaching and learning methods

	Type of instruction	Topic	Language of instruction	Group size	Weekly contact time	Workload [h]
	V	Animal Ecology	en	20	1	60
	P	Methods in biodiversity monitoring	en	20	2	90

3. Prerequisites for the module

compulsory	None
recommended	None

4. Degree program allocation

	Study program	compulsory/ elective	Semester
	MSc OEP-Biology	Elective	2

5. Requirements for the award of credits (ECTS)		6. Credits
Required achievements	none	5
Assessment (incl. weighting) and examination language	Written report (protocol), (100%), en.	

7. Frequency				8. Workload	9. Duration
Winter semester	☐	Winter and summer semester	☐	**150h**	**1 sem.**
Summer semester	☒				

Module coordination

Teacher	Prof. Dr. Christoph Scherber
Module coordinator	
Institute/Department	Zoological Research Museum Alexander Koenig, Centre for Biodiversity Monitoring

Further information

(Reading lists, information links etc.)	