SYLLABUS – SECOND SEMESTER (M1S2)

Master Biodiversity, Ecology and Evolution

International Pathway "Evolutionary Biology"

TITLE OF UNIT: From genotype to phenotype (Virginie Cuvillier, Associate Professor)

NUMBER of ECTS: 3
Number of hours: **Lectures: 17.5h**, **Tutorials: 8h**
Personal workload (hours expected to be dedicated to, including supervised projects): **46,5 hours**

Description of the module

General aims
Better apprehend biological systems complexity and their diversity
Acquire global knowledge about molecular and physiological processes that contribute to phenotypic diversity
Combine knowledge from different scientific domains (molecular and cellular biology, physiology, ecophysiology) to better understand phenotypic variation

Content summary
- Genetic regulatory networks: regulation of genetic expression; genetic interactions
- Perception of the variable environment: cellular and molecular consequences
- Integrative biology of organisms: physiological regulatory networks (PRNs) and their applied applications

Expected knowledge and skills:
To be able to integrate concepts and knowledge from molecular, cellular and organismal biology
To be able to understand scientific articles, perform critical analysis and oral presentation

EVALUATION MODE (final exam, oral defense, report,...)	Ratio of the final grade
Final exam	**60%**
Ongoing assessment (oral)	**40%**

TITLE OF UNIT: Theoretical modeling (Sylvain Billiard, Associate Professor)

NUMBER of ECTS: 3
Number of hours: **Lectures/Tutorials: 18h**
Personal workload (hours expected to be dedicated to, including supervised projects): **54 hours**

Description of the module

General aims
Be able to translate an evolutionary or ecological problem into a model in order to address a specific question or make predictions.

Content summary
- Population genetics model and adaptive walks
- Phenotypic models, adaptative dynamics and evolutionarily stable strategies
- Stochastic models of population dynamics and polymorphism maintenance
- Evolution of species communities

Expected knowledge and skills:
Direct abilities:
- Modeling a specific problem
- Analyzing a deterministic dynamical system (ODE, stability analysis)
- Writing a stochastic models and approximating invasion probability
Indirect abilities:
- Mathematical training
- Programming for simulations and numerical analysis of a model

EVALUATION MODE (final exam, oral defense, report,...)	Ratio of the final grade
Final exam (Oral presentation of the analysis of a simple model)	**100%**
Ongoing assessment	**0%**

TITLE OF UNIT: Ecology: from theory to experiments (Anne Duputié, Associate Professor)

NUMBER of ECTS: 3
Number of hours: **Lectures: 11h**, **Practicals: 16h**
Personal workload (hours expected to be dedicated to, including supervised projects): **45 hours**

Description of the module

General aims
The course aims are that students gain insight into theoretical and applied aspects of ecology, with a special emphasis on species' geographic distributions in a changing world. The course includes a project work, in which students will design an experiment and/or plan field work, perform this field work or short experimental project, analyze and interpret their data and write a short report.

Content summary
Lectures:
- How to measure fitness?
- How are life-history traits connected to species' geographic distributions?
- How and at what pace do life-history traits evolve?
- Contemporary evolution in a changing world
- Species interactions in relation to environmental gradients
- Assessing biodiversity using metabarcoding approach

Practicals: Students will lead a project in small groups. For example, they could assess how climate change can affect species' phenology and geographic distribution (through designing experiments aiming at calibrating phenological models for common plant species). Alternatively, they could assess how intra and interspecific interactions vary along an environmental gradient (e.g., pollution gradient). Or, they could estimate biodiversity in samples from different environmental conditions, using a metabarcoding approach. In either case, students will be expected to perform a bibliographic search, to design their protocol, perform the experiment, analyze their data and write an individual report.

Expected knowledge and skills:
Direct:
- based on examples, understand how environmental constraints drive local adaptation and species assemblages.
- design a realistic yet scientifically valid protocol
- perform field work and an experiment in the field of ecology

Indirect:
- work in a small team
- perform an efficient bibliographic search
- mobilize the knowledge acquired in biostatistics and R programming language to analyse data
- write a report in English

EVALUATION MODE (final exam, oral defense, report,...)	Ratio of the final grade
Final exam (Report and oral presentation)	**50%**
Ongoing assessment (design a protocol, carry out experiments/data analysis)	**50%**

TITLE OF UNIT: Experimental approaches in Ecology (Isabelle De Cauwer, Associate Professor)

NUMBER of ECTS: 3
Number of hours: **Lectures: 7h**, **Practicals: 20h**
Personal workload (hours expected to be dedicated to, including supervised projects): **45 hours**

Description of the module

General aims
- Formulating a scientific question in ecology and identifying relevant hypotheses,
- Designing an experimental protocol to tackle a question in ecology, while taking into account the logistic / biological constraints,
- Choosing and implementing appropriate statistical analysis with regard to the scientific question.

Content summary
At the beginning of the term, students will get tutorials on experimental design, data set manipulation and statistical analysis. Each student will then be assigned a scientific question in ecology and will create an experimental protocol to tackle that question. Finally, students will receive a real-life data set corresponding to the initial scientific question and will analyze it using statistical tools.

Expected knowledge and skills:
Direct skills:
- Manipulating data sets in ecology (formatting, producing graphic outputs, carrying out statistical analysis) with various software programs (Excel and R).

Indirect skills:
- Presenting a scientific reasoning, both in synthetic written documents and in oral presentations,
- Developing a critical sense by evaluating the relevance of experimental protocols and statistical analysis carried out by their peers.

EVALUATION MODE (final exam, oral defense, report,...)	Ratio of the final grade
Final exam (2 oral presentations)	**50%**
Ongoing assessment (2 small reports)	**50%**

TITLE OF UNIT: Analysis of empirical population genetics data (Jean-François Arnaud, Professor).

NUMBER of ECTS: 3
Number of hours: **Lectures: 2h**, **Practicals: 25h**
Personal workload (hours expected to be dedicated to, including supervised projects): **45 hours**

Description of the module

General aims:

Content summary

Expected knowledge and skills:

EVALUATION MODE (final exam, oral defense, report,...)	Ratio of the final grade
Final exam (oral report in front of a jury)	**100%**

TITLE OF UNIT: Multivariate statistics (Catherine Crônier, Professor)

NUMBER of ECTS: 3
Number of hours: **Lectures: 3h**, **Practicals: 6h**, **Tutorials: 3h**
Personal workload (hours expected to be dedicated to, including supervised projects): **60 hours**

Description of the module

General aims:
Students will get an introduction into multivariate data analysis and its application to problems in biology and paleontology.

Content summary

- Introduction: matrices, distributions, variance, covariance
- Data reduction: ordination and clustering methods
- Discrimination and classification
- Multivariate hypothesis testing
- Application of multivariate data analysis in biology and paleontology

Expected knowledge and skills:

- Knowledge on various ways to analyze multivariate datasets, and therewith on how to use multivariate statistics to test hypotheses in biology and paleontology
- Formulating hypotheses and interpreting results
- Communicating methods and results

EVALUATION MODE (final exam, oral defense, report,...)	Ratio of the final grade
Final exam (oral defense)	**?**
Ongoing assessment (data analysis, report)	**?**

TITLE OF UNIT: Research in "Global Changes & Biodiversity" (Anne Duputié, Associate Professor)

NUMBER of ECTS: 3
Number of hours: **Tutorials: 12h**
Personal workload (hours expected to be dedicated to, including supervised projects): **60 hours**

Description of the module

General aims:
This course will be based on seminars given by a panel of researchers active in the field of ecology and evolutionary ecology, especially in the context of global change.

Content summary

1. Interspecific interactions along environmental gradients
2. Geographic range limits and range shifts
3. Tolerance to pollutants

Expected knowledge and skills:
Integrative biology; Ecology ; Evolutionary Ecology ; Theoretical modeling ; Biostatistics

EVALUATION MODE (final exam, oral defense, report,...)	Ratio of the final grade
Final exam (peer reviewing of recently posted preprints on BiorXiv)	**100%**

TITLE OF UNIT: 2 months Internship (Isabelle De Cauwer, Associate Professor)

NUMBER of ECTS: 9
Number of hours: 280h

EVALUATION MODE (final exam, oral defense, report,...)	Ratio of the final grade
Final exam	**?**
Ongoing assessment (literature review and analyze)	**?**