COURSE DATA

Data Subject	
Code	46736
Name	Paleobiología y sistemática paleontológica
Cycle	Master's degree
ECTS Credits	4.5
Academic year	2024 - 2025

Study (s)

Degree	Center	Acad. year	Period
2266 - Master's Degree in Applied Palaeontology	Faculty of Biological Sciences	1	First term

Subject-matter

Degree	Subject-matter	Character
2266 - Master's Degree in Applied Palaeontology	1 - Fundamentals of palaeontology	Obligatory

Coordination

Name	Department
BOTELLA SEVILLA, HÉCTOR	356 - Botany and Geology
FERRON JIMENEZ, HUMBERTO GRACIAN	356 - Botany and Geology

SUMMARY

The course in Paleobiology and Paleontological Systematics covers a wide range of fundamental topics to understand the evolution and classification of living organisms over geological time. We will begin by exploring evolutionary ideas and their history, from early speculations to the synthetic theory of evolution, integrating genetics and natural selection. We will analyze the evolutionary reading of the fossil record to interpret evolutionary rates and patterns, distinguishing between microevolution and macroevolution. Basic concepts of systems theory and its application to evolution will be introduced, along with studying individuals and units of selection at different levels. Gradualism and punctuated equilibrium will be discussed, as well as the decoupling between micro and macroevolution. The stochastic aspects of evolution, observed through paleontological data, will also be considered.

We will address macroevolutionary mechanisms and the relationship between diversity and disparity in morphological evolution, including the consideration of embryonic development through evo-devo. Concepts of biomorphodynamics will be presented, analyzing morphology as evidence of evolutionary change and the factors that determine organic form, with approaches to evolutionary, theoretical, and functional morphologies, as well as isometry and allometry. We will discuss the constraints on morphological evolution and move towards an extended theory of evolution. The role of extinctions in macroevolution will be a central topic, classifying extinctions into background, mass, and episodic, and examining the classical causes of mass extinctions.

We will study the dynamics of biodiversity during the Phanerozoic, including evolutionary faunas and floras. We will analyze the implications of the evolutionary process in the classification of living organisms, with an evolutionary conception of the tree of life. Taxonomy, systematics, and classification will be reviewed, along with the fundamentals of phylogenetic reconstruction, highlighting the use of homology in systematics. Techniques, schools, and computer tools for classification in paleontology will be addressed, including taxonomic nomenclature codes, and the construction of phylogenetic trees from morphological characters, including the use of cladograms. Finally, the course will include the handling of software for cladistic analysis, providing a comprehensive and practical understanding of paleontological systematics.

PREVIOUS KNOWLEDGE

Relationship to other subjects of the same degree

There are no specified enrollment restrictions with other subjects of the curriculum.

Other requirements

No enrollment restrictions with other courses in the study plan have been specified. It is recommended, though not essential, to have basic knowledge of zoology, botany, and ecology, as well as geology and paleontology.

COMPETENCES (RD 1393/2007) // LEARNING OUTCOMES (RD 822/2021)

LEARNING OUTCOMES (RD 1393/2007) // NO CONTENT (RD 822/2021)

By the end of the course, students will be able to understand the theory of evolution, its postulates, and its areas of application, as well as its impact on the development of science. They will have a clear understanding of the historical nature of the evolutionary process, recognizing its irreproducibility and contingency, as well as its connection to natural laws. Students will understand that biodiversity is the result of evolution, evidenced by the fossil record, which allows for the chronological ordering of historical events. Additionally, they will recognize that biodiversity has been produced through the origination of new species, accompanied by the extinction of others. They will grasp the importance of critical events, such as mass extinctions, to examine practical consequences in evolution.

Furthermore, students will appreciate the temporal dimension of the origin and evolution of life and its implications. They will differentiate between systematics, taxonomy, and classification, and will know the various classification systems, as well as the major taxonomic groups and their position in universal phylogenetic reconstruction. They will be able to discriminate between homologies and homoplasies, recognize taxonomic categories, and apply the rules of biological nomenclature. They will also learn the standards for establishing groups of organisms and differentiate between natural selection and evolution. Finally, they will be capable of constructing and interpreting phylogenetic trees and using basic software for phylogenetic reconstruction, such as Phylip and TNT, applying this knowledge in the classification of organisms.

DESCRIPTION OF CONTENTS

1. THEORETICAL MODULE

1. Paleobiology: Introduction
1.1. Basic Concepts and Historical Context
Definition of paleobiology and its relevance.
Historical milestones in the study of fossils.
1.2. The Nature of the Fossil Record
Geographic and Environmental Distribution of Fossiliferous Rocks
Potential for Fossil Record Preservation
Measures of (In)completeness of the Fossil Record
Sampling of the Fossil Record
1.3. The Species in Paleontology
The Concept of Species
Species and Speciation
Recognition of (Morpho)species in the Fossil Record
(Morpho)species in the Fossil Record and Geological Time
2. Global Diversification and Extinction
2.1. Basic Concepts and Historical Context
2.2. Global Diversification
Methods for Constructing Global Diversity Curves
Development of the Coupled Logistic Model
Alternative Scenarios to the Coupled Logistic Model
Evolutionary Faunas in Continental Environments
2.3. Extinction
Background Extinction vs. Mass Extinction
Background Extinction
- Vulnerability to extinction and selectivity.

Mass Extinction
- Is there cyclicity in mass extinctions?
- Possible biases in the study of extinctions.

2.4. Recovery from Mass Extinctions
Phases of Recovery
The Evolutionary Significance of Mass Extinctions

2.5. Dynamics of Origination
Possible Key Role in Mass Extinctions
Trends in Origination (and Extinction) Rates in Marine Environments
Dynamics of Origination in Terrestrial and Marine Environments
2.6. Diversification and Extinction in the Phanerozoic
Ecological Alterations Associated with Extinction and Diversification Processes
Causes of Extinc

Chapter 2. Populations, species and fossil record
-The species in paleontology.
-Actualistic aspects: speciation, pre- and postzygotic reproductive isolation, and biogeography.
-Determination of species: determination criteria.
-How species are inferred through the fossil record: their possibility of determination.
-Species in the fossil and stratigraphic records: spatial and tempo

2. PRACTICALS

Session 1: Laboratory
The Problem of Biological Classification
Handling Morphological Characters
Character States
Recording Quantitative and Qualitative Characters
o Coding and Ordering of Characters
Creating Binary Character Matrices
Handling Complex Characters
Creating Multi-state Character Matrices
Session 2: Problems
Principles of Phylogenetic Systematics
Work Stages
Types of Characters and Coding
Homology Criteria
Character Coding and Polarity
o According to External, Ontogenetic, and Stratigraphic Criteria
Application of Parsimony in Testing Phylogenetic Hypotheses
Information Derived from Phylogenetic Hypotheses
Types of Groups
o Recognition of Synapomorphies, Plesiomorphies, Autapomorphies and their Significance
Principle of Simplicity
Parenthetical Notation
Root and Rooting
Topologies
Manual Construction of Cladograms
Exercise Resolution
Sessions 3 and 4: Informatics
Cladistic Methods

Application of Software for Phylogenetic Reconstruction by Parsimony Algorithms
Minimum Length Trees
Character Optimization
Tree Parameters
Interpretation of Obtained Results and their Implications
Consensus Trees
Statistical Support and Confidence of Groups and Trees
Interpretation of Results and their Implications for Biological Classification and Nomenclatural Aspects

WORKLOAD

ACTIVITY	Hours	% To be attended
Theory classes	34,00	100
Laboratory practices	11,00	100
TOTAL	45,00	

TEACHING METHODOLOGY

Theoretical Classes (34 hours in-person)

Methodology:

- **Lectures:** Delivered through PowerPoint presentations to facilitate the understanding of key concepts.
- **Audiovisual Resources:** All necessary materials will be available on the university's teaching support platform (virtual classroom), ensuring early access for students.
- **Assessments:** Tests and exams will be conducted to measure learning progress.

Practical Classes (6 hours in-person) and Problem-Solving Sessions (3 hours in-person)

Methodology:

- **Introduction and Planning:** Each session will start with a detailed introduction to the practice, establishing clear objectives.
- **Use of Databases:** Students will work with databases related to the fossil record for in-depth and relevant analysis.
- **Calculation of Evolution and Extinction Rates:** Students will learn to plan and calculate evolution and extinction rates.
- **Cohort Analysis:** Focus will be on analyzing cohorts and pseudocohorts, identifying different types of extinction (background, episodic, and mass).
- **Application of Parsimony:** Instruction on applying parsimony in formulating phylogenetic hypotheses.
- **Use of Algorithms:** Exploration of algorithms to measure similarity and distance among individuals, including the transformation of quantitative data and construction of hierarchical dendrograms.

- **Advanced Software Tools:** Utilization of specialized software for phylogenetic reconstruction in Paleontology, applying real data matrices from various fossil groups and generating consensus trees.

Individualized Evaluative Work

- **Practice Guidelines:** Each student will have a guide to read before each practical session. Practices will be organized into problem-solving and computer sessions, presenting complementary exercises to reinforce learned concepts.
- **Practice Objectives:** At the beginning of each session, the instructor will present the specific objective of the practice and review the fundamental concepts to be applied in the exercises.
- **Instructor Supervision:** During the practice, students will work autonomously with continuous supervision and support from the instructor.
- **Report Preparation:** Each student must submit a corresponding report reflecting the work done and the knowledge acquired.

EVALUATION

Evaluation Components

- **Final Exam:** This will consist of a written exam combining multiple-choice questions, short answer questions, and development questions, allowing for a comprehensive assessment of the knowledge acquired.
- **Final Practical Test:** This will take place in the computer lab and will consist of a practical exercise using the software learned throughout the course, applying simulated paleontological data.

Additional Considerations

In addition to the above components, the following will be taken into account:

- **Attendance and Engagement:** Attendance in classes and the engagement with the proposed activities.

Weighting

- **Final Exam:** 75%
- **Computer Lab Exercise:** 10%
- **Practical Work and Participation:** 15%

This evaluation structure is designed to provide a comprehensive assessment of student performance, encouraging both theoretical and practical learning.

REFERENCES

Basic

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Additional

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- Lamolda, M., ed. 2003. Bioevents: their Stratigraphical Records, Patterns and Causes. 141 pp. Editado Por Ayuntamiento de Caravaca de la Cruz, Murcia.