Methods and Processes in Biological Oceanography (MPOB) – 5 ECTS
Master’s in Marine Biology 2011/2012

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**LECTURERS:**

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**Objectives:**

1. Appreciate the functional diversity and ecophysiological attributes of different phytoplankton groups;

2. Understand the role of phytoplankton primary production and its underlying driving factors;

3. Develop analytical and discriminating skills in order to evaluate and apply different quantitative techniques used to evaluate phytoplankton biomass, composition, production, growth, and mortality.

4. To understand heterotrophic bacterial processes, marine bacterioplankton production and regulating factors in the sea.

5. To understand the main principles and applications for oceanography of remotely and satellite acquired data.

6. To access and manipulate satellite SST (Sea Surface Temperature) and chlorophyll a to analyze seasonal and spatial phytoplankton distribution in the oceans.

**Program (Lectures and Lab. Sessions)**

1 - Bacterioplankton (HG)

1.1 Bacterial processes and regulating factors *(Week 1 incl. May 16)*

1.1.1 Bacterial activity and growth efficiency.

1.1.2 Factors regulating production of heterotrophic bacterioplankton: *bottom-up* (temperature, organic matter, nutrients, etc) and *top-down* (grazing by protists, viral lysis) factors
1.2 Quantitative techniques to determine bacteria production *(Week 1/2)*

1.2.1 Techniques to determine abundance, biomass and activity of heterotrophic bacterioplankton

1.2.2 Techniques to determine bacterioplankton production
   1.2.2.1 Incorporation of $^3$H-thymidine in bacterial DNA
   1.2.2.2 Incorporation of $^{14}$C-leucine in protein fraction
   1.2.2.3 Biomass increase after removal of grazing impact

1.3 Quantitative techniques to determine viral lyses *(Week 2 incl. May 23)*

1.3.1 Methods to determine microbial mortality due to viral lyses
1.3.2 New conceptual models of viral lyses impact on microbial populations; implications for biodiversity and biogeochemical fluxes.

**Lab. Sessions (Weeks 4 & 5):**
1. Determination of total bacteria number and biomass using epifluorescence microscopy
2. Dilution technique to determine bacterioplankton growth and grazing by protists. This experiment will be set up jointly to determine phytoplankton growth and production.
3. Demonstration of bacterial production method using 14C-leucine
4. TP session to calculate TBN, bacterial biomass and production

2 - Phytoplankton (AB) *Weeks 3 & 4*

2.1 Primary production processes and drivers *(0,5 h)* *28 May 2012*
   2.1.1 Functional groups of phytoplankton
   2.1.2 Primary production: metabolic pathways and relevance in marine ecosystem
   2.1.3 Key biological processes and environmental drivers

2.2 Methods for measuring phytoplankton biomass and production *(2 h)* *28 May, 31 May, 6 June (OT) 2012*
   2.2.1 Evaluation of abundance, biomass, and composition of phytoplankton
      2.2.1.1 Sampling techniques
      2.2.1.2 Chlorophyll $\alpha$ as a proxy for biomass
      2.2.1.3 Specific biomarkers
      2.2.1.4 Use of direct and indirect optical techniques
      2.2.1.5 Molecular approaches
   2.2.2 Evaluation of phytoplankton production
      2.2.2.1 Oxygen production
      2.2.2.2 Radiocarbon labelling ($^{14}$C)
      2.2.2.3 Increment in biomass after predator removal
      2.2.2.4 Fluorescence techniques
      2.2.2.5 Use of remote sensing
   2.2.3 Evaluation of species-specific phytoplankton growth rates and production
2.3 Methods for measuring phytoplankton mortality (1,5 h) 6 June (OT), 7 June 2012

2.3.1 Modes of cell death: grazing, parasitism, viral lyses, apoptosis, sinking, and advection
2.3.2 Evaluation of biomass losses associated to sinking and parasitism
2.3.3 Evaluation of herbivory
   2.3.3.1 Differential size fractionation and dilution
   2.3.3.2 Use of metabolic inhibitors
   2.3.3.3 Use of tracer techniques (e.g., radiolabelled, and fluorescently labelled prey/prey surrogates)
   2.3.3.4 Hybrid techniques

2 - Phytoplankton Practical Sessions (AB)

2.1 Use of different methods to evaluate phytoplankton production in exposed and confined coastal ecosystems: oxygen production, and biomass increments (3,0 h) Week 4 (4 – 8 June 2012)
2.2 Use of the dilution technique to evaluate grazing exerted by phagotrophic protists on phytoplankton in exposed and confined coastal ecosystems (3,0 h) Week 4 (4 – 8 June 2012)
2.3 Data analyses and discussion (2,5 h) Week 5/6


3.1 Satellites and Sensors
   3.1.1 The basic elements and sampling characteristics of satellite orbits
   3.1.2 Sensors on satellites
   3.1.3 Atmospheric correction
   3.1.4 Positional registration
   3.1.5 Image processing

3.2 Oceanographic Applications: Infrared Measurement of Sea Surface Temperature
   3.2.1 Sea surface temperature from infrared radiometers
   3.2.2 Ocean Color
   3.2.3 Coastal Zone Color Scanner (CZCS)
   3.2.4 Sea-viewing Wide Field-of-view Sensor (SeaWiFS)
   3.2.5 MODIS

3.3 Ocean Color in relation to Phytoplankton Abundance and Growth (Lab. Sessions) Weeks 6, 7 & 8
   3.3.1 Acquisition of SST and Chlorophyll data from servers
   3.3.2 Selection of region of interest and elaboration of image stacks of weekly as well as annual means (e.g. Climatology)
   3.3.2 Detection of time and relative magnitude of the spring bloom
   3.3.4 Case-study: Effect of Australian dust storms on chlorophyll
Tutorial Sessions (2 h)

- 2 sessions 1 h each to be arranged by AB & HG

Additional Information

(1) Program, lecture material, lab protocols, bibliography, etc
See electronic site and personal pages (w3.ualg.pt/~hgalvao/MPOB)

(2) To consult lecturers, please fix day and time by e-mail.

Evaluation

- Exam: 60% & Practical Exam (AB & HG) + Lab Report (JL): 40%
- Exam – normal period (week 9), retake period (week 11)

To be admitted to the exam:
Attendance of 75% of practical sessions (lab and fieldwork), tutorial sessions and passing grade in remote sensing lab report (JL)

To pass course: final exam grade > 9.5

Recommended Bibliography


**Review Material**


**Scientific Journals of interest for Biological Oceanography**

Aquatic Microbial Ecology *(b) - 2004*
Continental Shelf Research *(a)*
Deep-Sea Research I *(a)*
Deep-Sea Research II *(a)*
Estuaries *(b) - 2003*
Estuarine Coastal and Shelf Science *(a)*
Harmful Algae *(a)*
Hydrobiologia *(a)*
Journal of Experimental Marine Biology and Ecology *(a)*
Journal of Geophysical Research *(c)*
Journal of Marine Research *(c)*
Journal of Marine Systems *(a)*
Journal of Phycology *(c)*
Journal of Plankton Research *(c)*
Limnology and Oceanography *(b) - 2002*
Limnology and Oceanography: methods *(b) – 2003*
Marine Ecology Progress Series *(b) - 2004*
Progress in Oceanography *(a)*

**Access:**

*(a) abstracts and pdf files available online in Base de dados on-line (see Biblioteca) *(b) abstracts and pdf files prior to 2002/2004 available in Journal webpage *(c) abstract available in Journal webpage*