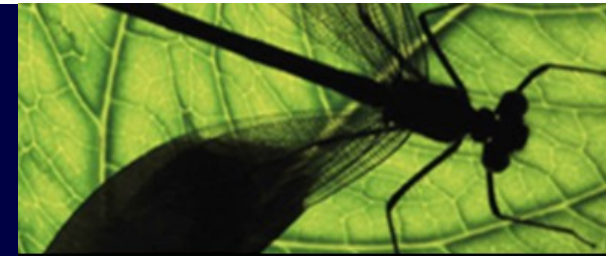


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DEGLI STUDI DI TRIESTE



BIOLOGIA AMBIENTALE

Laurea magistrale in
Ecologia e Sostenibilità
dei Cambiamenti Globali
- ESCG -

**Biomonitoring for environmental change
detection (6 CFU)**

Fabio Candotto Carniel, Mauro Tretiach
Dipartimento di Scienze della Vita

fcandotto@units.it

tretiach@units.it

Fabio Candotto Carniel



Researcher

**Università di Trieste,
Dipartimento di Scienze della Vita,
via Licio Giorgieri 10,
34127 Trieste, Italia**



**Bld. M, first floor down,
room B/03
e-mail: fcandotto@units.it**

Mauro Tretiach

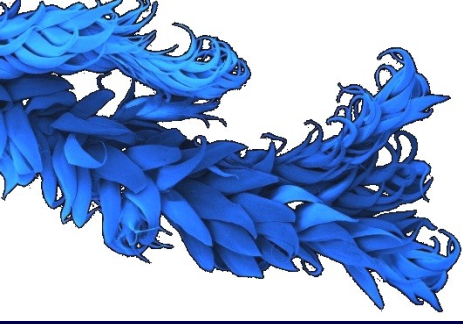


Full Professor in General Botany

**Università di Trieste,
Dipartimento di Scienze della Vita,
via Licio Giorgieri 10,
34127 Trieste, Italia**



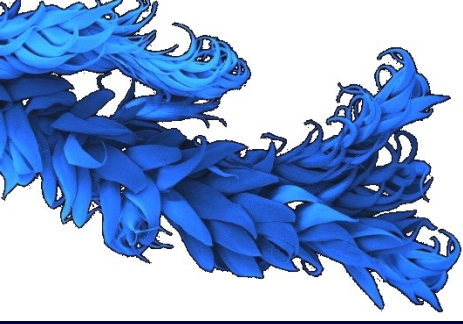
**Bld. M, first floor down,
room B/09
e-mail: tretiach@units.it**



Structure of this cycle of lessons:

Introduction:

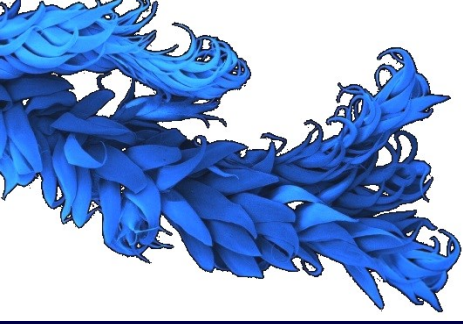
- Presentation: Contents, organisation, and modality of the final exam.
- What is “Environmental Change”? a perspective ranging from past to future eras also from your perspectives.
- Physico-chemical factors that can change: climate (temperature, water availability, precipitation, extreme events etc.), pollution (xenobiotic substances in water, air and soil matrices), land use (urbanisation, habitat fragmentation, de- and reforestation etc.).



Structure of this cycle of lessons:

Methodologies for describing past climate changes using organisms:

- **Paleo Palynology** (introduction to palynological analysis and its classic and new applications – the basic assumptions of paleopalynology - time range – methods and dating – pros and cons - examples);
- **Dendrochronology** (basic assumptions – time range – methods, dating and examples);
- **Coral chronology** (time range – basic assumptions – methods, dating and examples);
- **Paleobotany.**



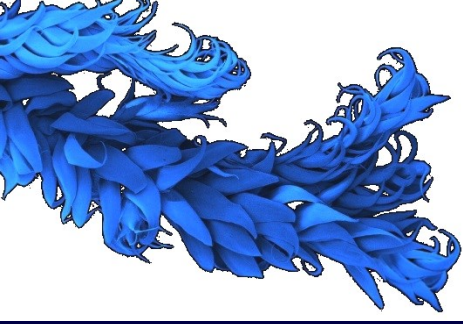
Structure of this cycle of lessons:

Why Biomonitoring of Environmental Change is needed? Two perspectives:

- (A) towards past eras, to define the conditions when chemical-physical data were not available, to calibrate or validate climatic reconstructions obtained by mathematical models;
- (B) towards the future, to predict possible scenarios at different levels (from single species to whole ecosystems and bioma).

The “basics” of Biomonitoring:

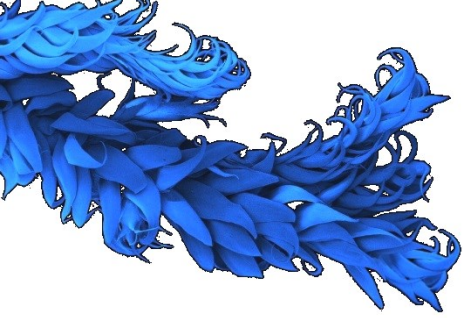
- why use organisms?
- Definitions of species, species communities and populations, ecological niche, habitat, ecological indices or ecological indicator values, with practical examples.
- Identification of groups of sensitive organisms that act as environmental sentinels.



Structure of this cycle of lessons:

Biomonitoring of extant changes in biorhythms:

- the basic of phenology: historical origin, causes, informational content and possible consequences for the environment;
- biorhythm alteration in different groups of animals (e.g. birds, mammals, insects) and in plants;
- Phenological changes at plant population and communities' level;
- miss-matches among interdependent species and possible evolutionary implications.



Structure of this cycle of lessons:

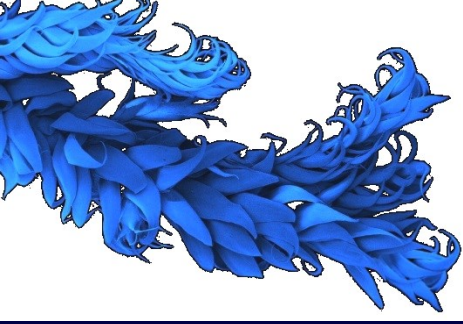
Biomonitoring of airborne pollutants.

Pollution as alteration of the chemical composition of environmental matrices, with special emphasis on air pollution. National and European regulatory framework on air pollution. The main persistent “generalist” air pollutants: SO_2 , NO_x , O_3 , PM_{10} , PAHs etc.

Why monitor air pollution with organisms? Identification of groups of sentinel organisms in the environment.

Bioindication with lichens, tobacco etc. to study the effects of single pollutants or mixtures of pollutants.

Bioaccumulation of persistent pollutants in lichens, mosses, vascular plants to study the distribution over space and time, and the intensity of depositions in environments around point, linear or multiple emission sources as compared to background deposition levels.



Structure of this cycle of lessons:

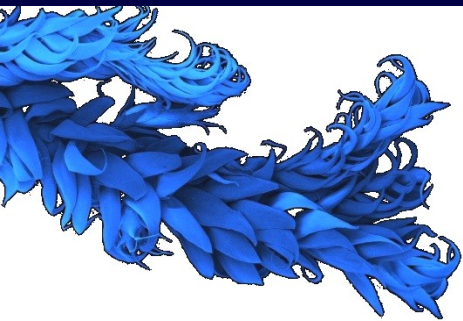
Evaluation of plant ecosystem functioning:

- Analysis of dynamics of carbon in the soil/ecosystem/atmosphere: Monitoring at different scales (3 hours);
- analysis of dynamics of nutrient and pollutant exchanges in the soil/ecosystem/atmosphere continuum: Monitoring at different scales.

AT THE END.... Seminars by the students

Students will give a speech of 30 min. on topics they will have selected among the main arguments treated in the course, with special emphasis on the specific interest of the student.

Each student will select three scientific papers, that will be discussed with the teachers in advance, and eventually integrated on the basis of the suggestions of the teachers. Then, the student will elaborate a presentation of c. ten to fifteen slides that will be commented upon in front of the class; questions by the colleagues and the teachers will follow.

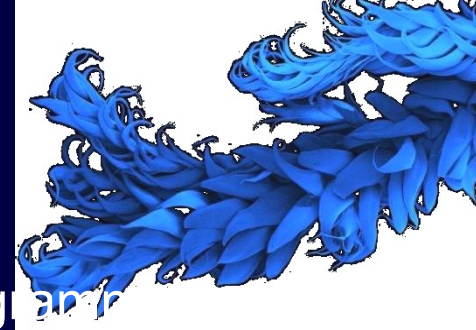


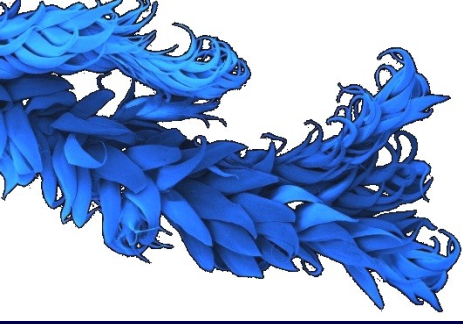
These were our (Fabio's & my) original ideas.

But....

When we started the discussion of a more detailed program, we discovered «the pleasure of discussion» on lots of arguments, which are new for us. Therefore, we elaborated a new proposal: to try a new approach to teaching, more «participatory». This does not exclude notions given «*ex cathedra*», but we would like to increase your active participation. When possible, both teachers will be present at each lesson, to increase the exchange of ideas, derived from different points of view.

We shall start with a survey, prepared by the students of the previous year in cooperation with the teachers of this course, discussing together the limits of the survey itself, its possible modifications and implementations, and the answers given. In a second time, this survey could be distributed to a larger audience.

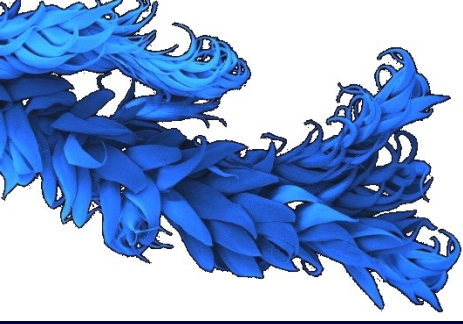




Materials for discussion & study is made available on Moodle.

Password needed.... **BIOMON2024*25!**

Attention! Just a few minutes before each lesson we load the slides of the lesson given that day.



Lessons are recorded by
Microsoft TEAMS.

The accession code to this Team is:

s472tj5

Recording on TEAMS

We must face immediately a critical point....

According to the internal rules of UniTS, all the lessons must be recorded by Teams, and are available for at least 14 days to a maximum of one year (we opted for one year).

BUT.... The recommendation is to stop the recording when there is a discussion, in which the students are requested to give their opinions.

NOW, our proposal is to maximise internal discussions, on whatever arguments. Lessons should be interactive, and we shall work for the success of such an approach. This is feasible if we do not need to interrupt recording every five (or less...) minutes.

A possible solution is to declare that, aware of the sensitivity of the matter, you accept to be recorded when expressing your personal opinion, knowing that the recorded matter will be seen by people who are not physically present in the room, and that the recorded material could be circulated – albeit illegally.

If you agree on this, I ask to each of you to give a spontaneous declaration of *consensus* just now on.

[...]

We would like to offer you also some practical activities, also thanks to some of our postdocs and PhD students. These activities are «NOT REQUIRED» for the admission to the final exam, but are an opportunity to make some practice and ... see the world.

	Monday	Thursday	Wednesday	Thursday	Friday	
09:30	ECONOMICS OF ECOSYSTEM SERVICES	ENVIRONMENTAL STATISTICS AND MODELLING		BIOMONITORING FOR ENVIRONMENTAL CHANGE DETECTION	BIOMONITORING FOR ENVIRONMENTAL CHANGE DETECTION	
10:00				ENVIRONMENTAL STATISTICS AND MODELLING		
10:30						
11:00						
11:30						
12:00						
12:30				REMOTE SENSING OF ENVIRONMENTAL CHANGES		
13:00						
13:30		ECONOMICS OF ECOSYSTEM SERVICES	BIOMONITORING FOR ENVIRONMENTAL CHANGE DETECTION			
14:00						
14:30	GEOGRAFIA DEI CAMBIAMENTI GLOBALI E CITTA' SOSTENIBILI				DIRITTO AMBIENTALE E DIRITTO DELL'IMPRESA	
15:00						
15:30		GEOGRAFIA DEI CAMBIAMENTI GLOBALI E CITTA' SOSTENIBILI	DIRITTO AMBIENTALE E DIRITTO DELL'IMPRESA			
16:00						
16:30						
17:00						
17:30						
18:00						



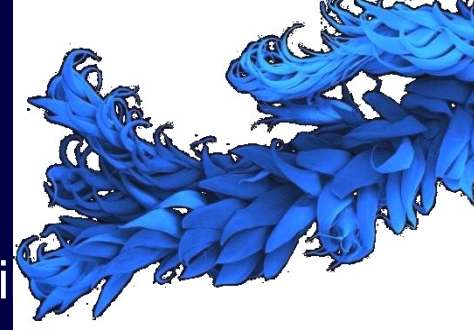
Final Exam (1/2)

Exams can be given at request, by writing an email to the teachers some weeks before to fix the date.

Duration: no more than one hour.

How: Oral exam on the entire program; the first question is by drawing lots for one of the main arguments of the course, followed by others at fixed intervals (+6, +12 or +18 lessons, as decided by the student h**self at the beginning of the exam).

Furthermore, we ask the discussion of three scientific papers selected by the student (and validated by the teachers) on topics pertinent to the course (different from those of the seminar).



Final Exam (2/2)

The oral exam aims at assessing students' skills on using the concepts learned in the course effectively, appropriately and with specific language, the concepts learned in the course.

The grading system applied is:

(18-24): sufficient or fair knowledge of the subject, adequate mastery of the technical language;

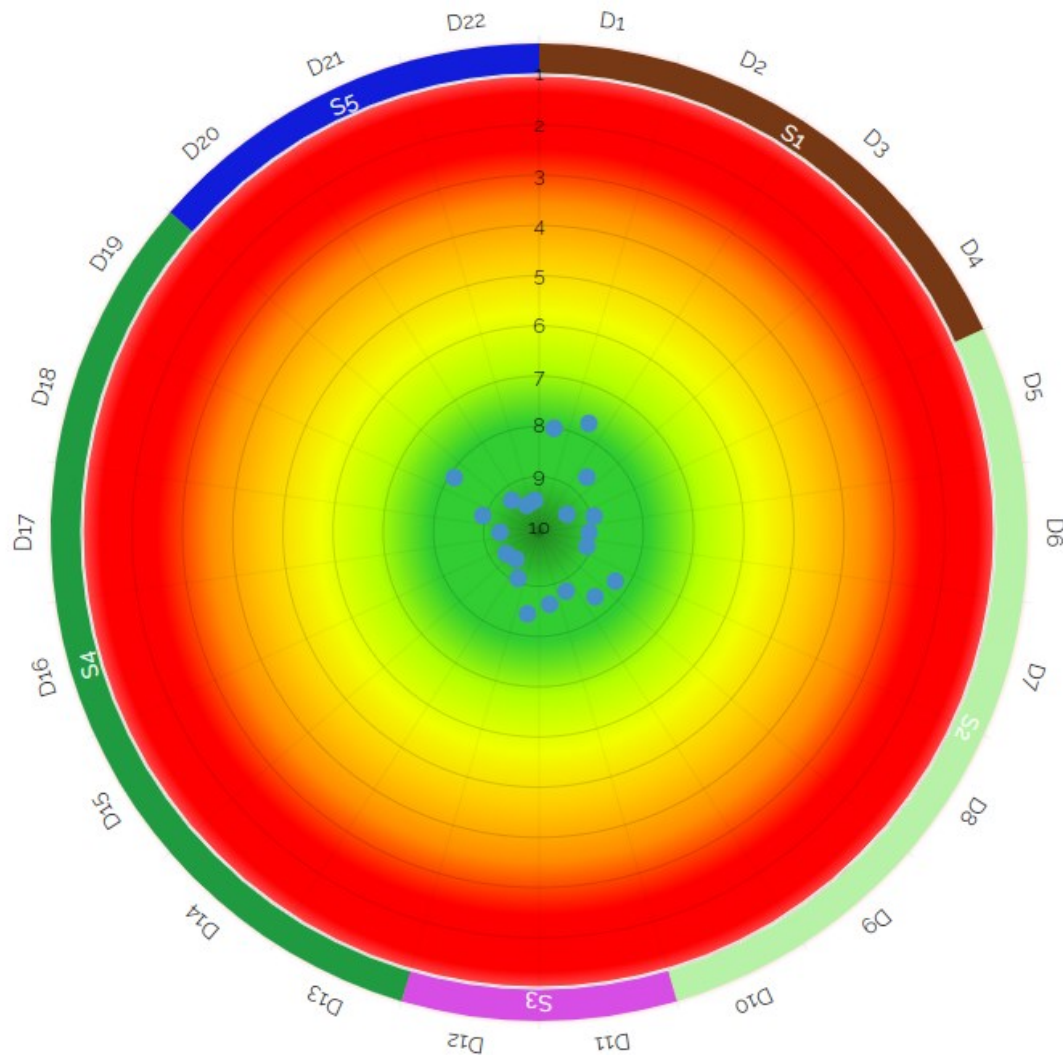
(25-27): good or very good knowledge of the subject, technical language proficiency, essential ability to connect the themes addressed during the course;

(28-30 with honours): excellent knowledge of the subject and technical language proficiency, autonomous critical and analytical skills, and ability to apply acquired knowledge to concrete scenarios

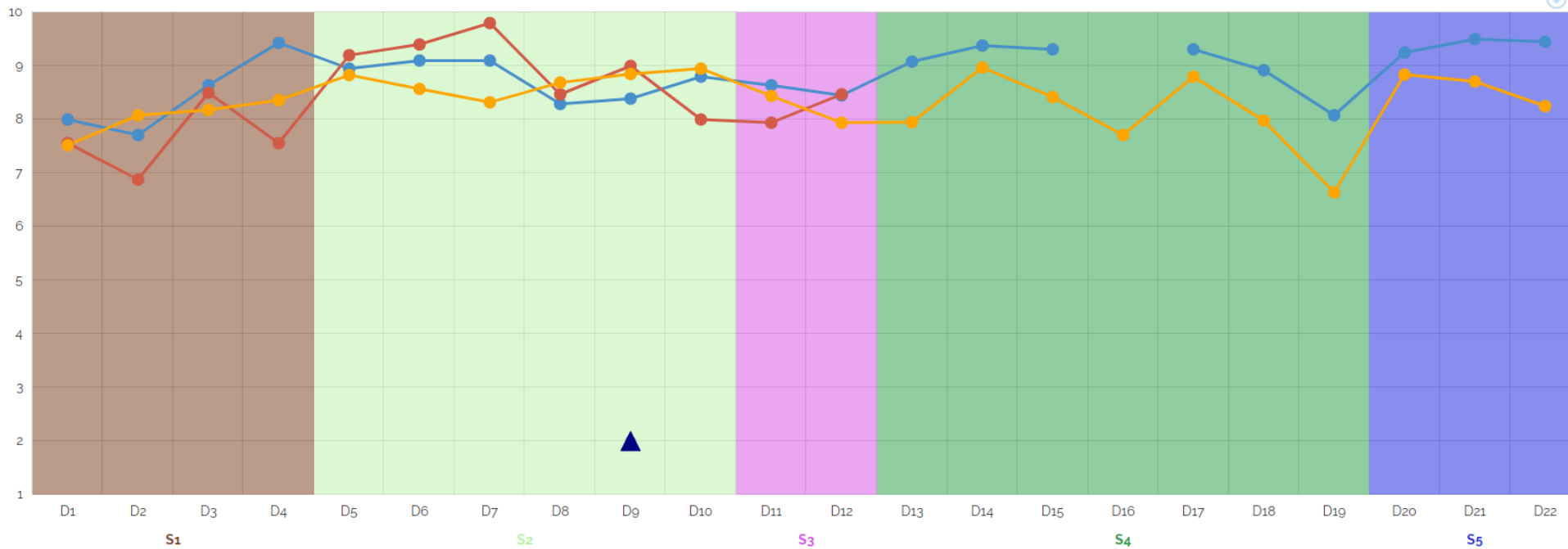
Biomonitors & friends...



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Biomonitors & friends...



■ integrare con attività su campo o in laboratorio, ovviamente covid permettendo.

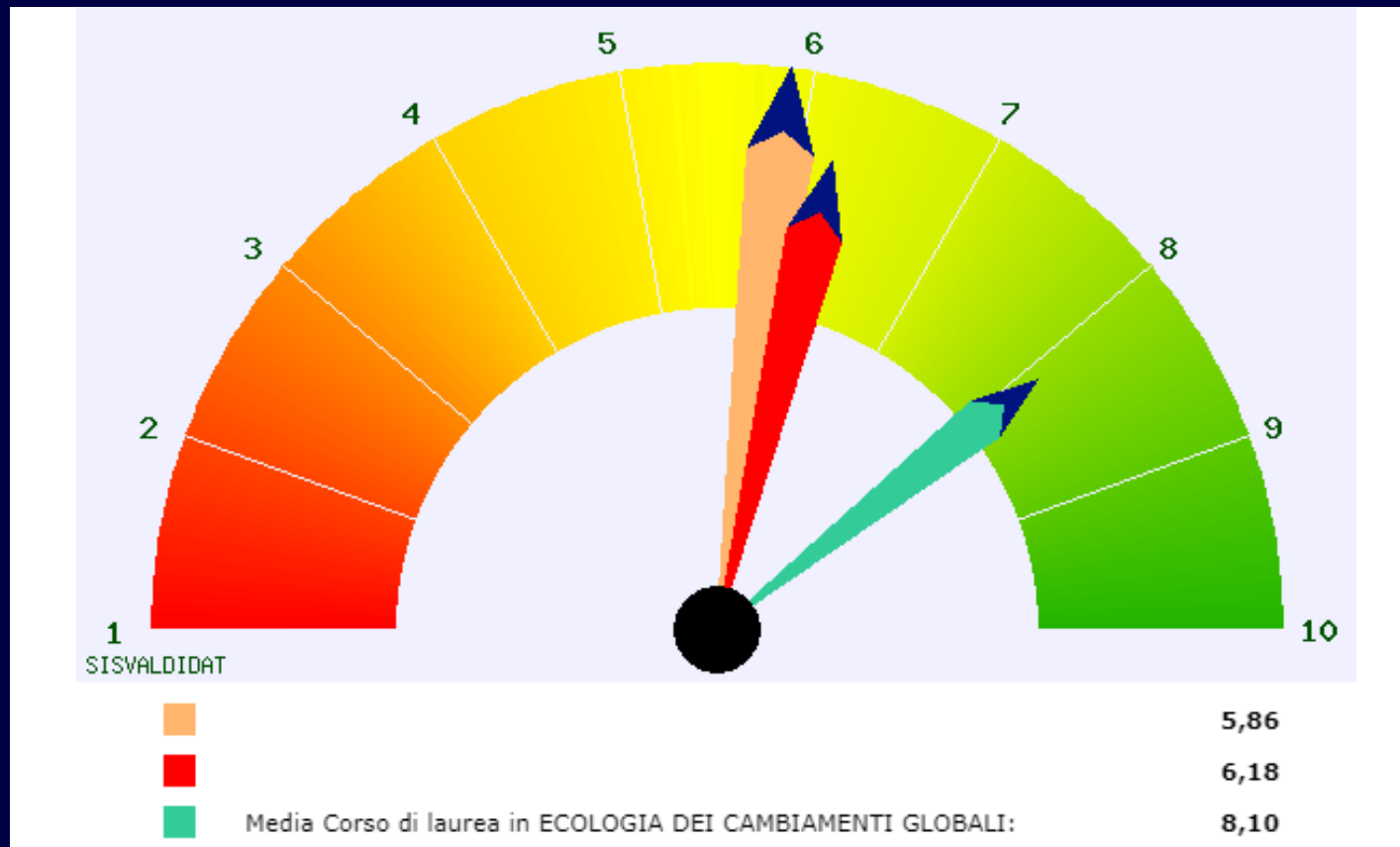
Questo corso AA 2020-21 —

Questo corso AA 2019-20 —

Tutti i corsi di ECG 2020-21 —

Biomonitors & friends...

Study Load



B1-2 presentazione; modalità desame; inquinamento 10 02 (2).ppt [modalità compatibilità] - Microsoft PowerPoint

Corso: 631SM-1 - BIOMONITORAGG... Dipartimento di Scienze della Vita

Non sicuro | dsv.units.it

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Attività editoriale
Attività congressuale


Biomedicina
Biologia Ambientale
Psicologia

Trieste Symposium on Perception and Cognition e il

18
21

Plant and animal ecophysiology

Research Area: Environmental Biology



DIPARTIMENTO DI SCIENZE DELLA VITA

Posta elettronica certificata - PEC: dsv@pec.units.it

Direttore
prof. Mauro Tretiach
Tel. (+39) 040 558 8788
Cell. 338 6945086
e-mail: direttore@units.it

Segreteria amministrativa
rag. Maria Teresa Grione
Tel. (+39) 040 558 8792, 8780
Fax: (+39) 040 558 2134
e-mail: segramm@dsv@units.it

Vice Direttore
prof. Daniele Sblattero
Tel. (+39) 040 558 8681
Cell. 334 6782476
e-mail: direttore@units.it

Segreteria didattica
prof. Mauro Tretiach
Tel. (+39) 040 558 8774
Fax: (+39) 040 558 4220
e-mail: didattica@dsv@units.it

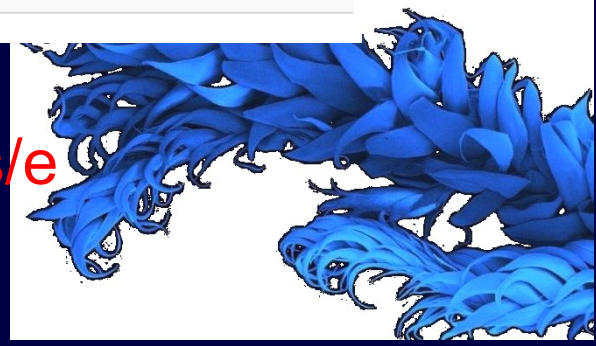
Research Groups

- Plant physiological ecology (Prof. Nardini)
- Animal physiological ecology (Prof. Giulianini)
- Biology of lichen symbiosis (Prof. Tretiach)

dsv.units.it/ricerca/ambiti/biologia-ambientale



<https://dsv.units.it/en/research/researchareas/environmental-biology?q=en/node/18749>



<https://dsv.units.it/en/research/researchareas/environmental-biology?q=en/node/18749>

BIOLOGY of LICHEN SYMBIOSIS



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Mauro Tretiach, PhD,
Full professor



Fabio Candotto Carniel,
PhD, Researcher



Wendalina Tigani,
PhD,
Post-Doc



Enrico Boccato,
MSc, PhD student,
XXXVII° cycle



Nida Zaib,
PhD student,
XXXVIII° cycle



Ceseri Sofia,
PhD student,
XXXIX° cycle



Mazari Ait Kaci,
PhD student,
XL° cycle

BIOLOGIA DELLA SIMBIOSI LICHENICA



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Our studies are focused on the following main themes:

- 1) Revision of critical taxa of the European lichen flora, and floristic research;
- 2) Ecophysiology and biology of lichens and their apo-symbionts;
- 3) Biomonitoring with lichens.
- 4) Ecotoxicology of nanomaterials

Biomonitoring & friends...



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In the years, a good, satisfactory settlement has been reached between basic and applied research, a sort of virtuous loop where discoveries from **Systematics**, **Physiology** and **Ecology** are immediately integrated in the applicatory field of **Environmental Biomonitoring**. The latter sustains a large part of the cost of the former activities, thanks to a number of contracts with private and public companies.

Most of these activities are developed with students, and are treated within teaching courses of the MasterDegree in Global Change Ecology.

Biomonitors & friends...

Systematics

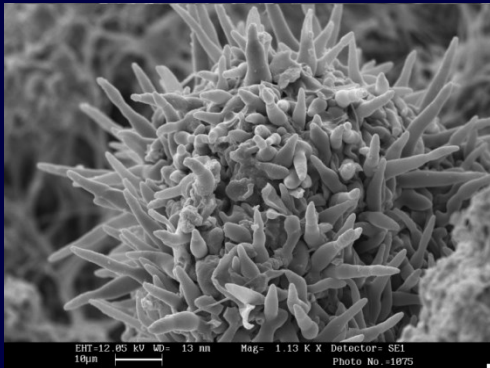
Ecophysiology

Biomonitoring



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Basic researches in the field of **Systematics** mainly concern the critical revision of problematic taxa and the description of new species, based on the field collection of specimens, often in beautiful landscapes.



Biomonitors & friends...

Systematics

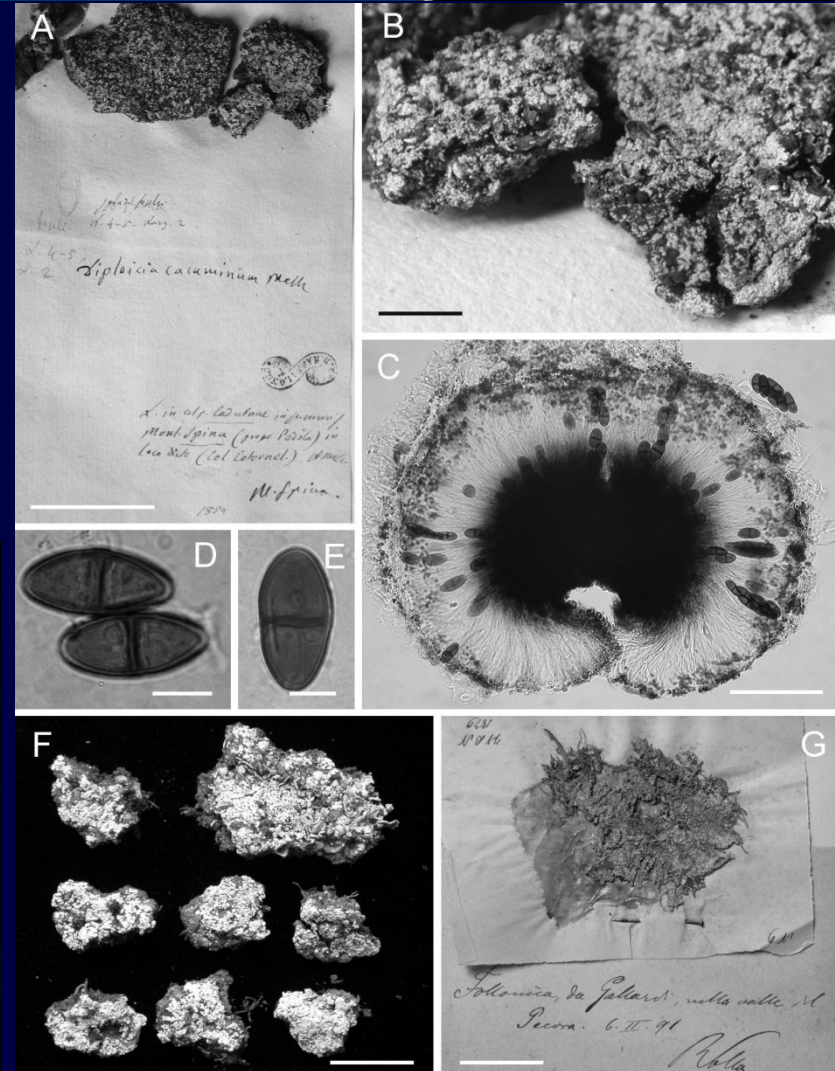
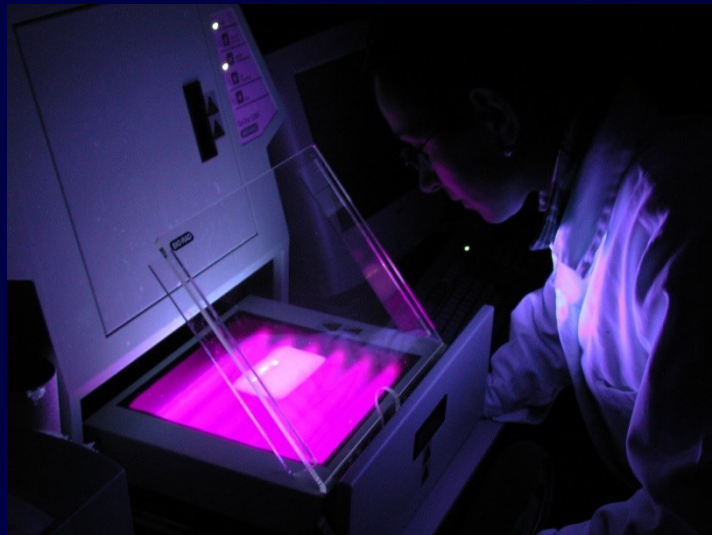
Ecophysiology

Biomonitoring



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Traditional, morpho-anatomical studies, eventually integrated by SEM and TEM observations, are implemented with DNA sequencing of both myco- and photobionts. Phylogenetic trees are built up, and compared with the morphological ones.



Biomonitors & friends...

Systematics

Ecophysiology

Biomonitoring



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New arrangements are proposed, always based on the study of type materials that needs hard work in historical collections.



72

Nova Plantarum

D I S T R I B U T I O X I.

*Plantae flore apetalae, astemone, seu apode, apice, aut per
capsulam singularem constanter, sed sterili, cujus embryo ab
in fructum multicapsularem.*

Biomonitors & friends...

Systematics
Ecophysiology
Biomonitoring



Basic researches in the field of **Ecophysiology and Biology** mainly concern photosynthetic activity in dependence to environmental factors (also pollutants) and photobiont characteristics.



Biomonitoring & friends...

Systematics

Ecophysiology

Biomonitoring

The most recent researches were aimed at describing:



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1. the factors affecting chlorophyll a fluorescence in species of foliose and crustose lichens, along ecological gradients;
2. the reproductive cycles within the green algal genus *Trebouxia*, the most common photobiont of the lichen symbiosis, and the interplay between germinating ascospores and algal zoospores for the resynthesis of the lichen symbiosis;
3. the discovery of WHAT, a new devitalization technique for the eradication of biodeteriogens of open-air monuments.

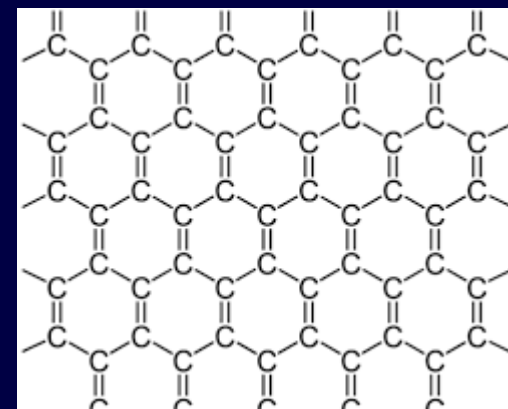
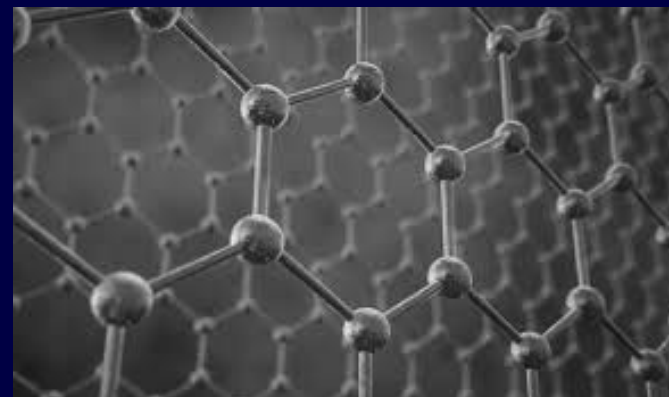
Biomonitors & friends...

Systematics
Ecophysiology
Biomonitoring



Fabio later will introduce our research in the field of ecotoxicology of 2D-nanomaterials, starting from **Graphene Related Materials, GRMs**.

Fabio will describe in many details these activities, better than I can do, because he was the reference person for all the researches of our group on this topic.



Biomonitoring & friends...

Systematics
Ecophysiology
Biomonitoring



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Biomonitoring with lichens and mosses is one of the traditional, main activities of our group.

In co-operation with other national and international research centres, researchers of our Department developed new methodological approaches, experimental protocols, and guidelines approved by national authorities (e.g. ISPRA).

These activities are supported by dozens of applicatory studies, carried out by appointment of public and private companies.

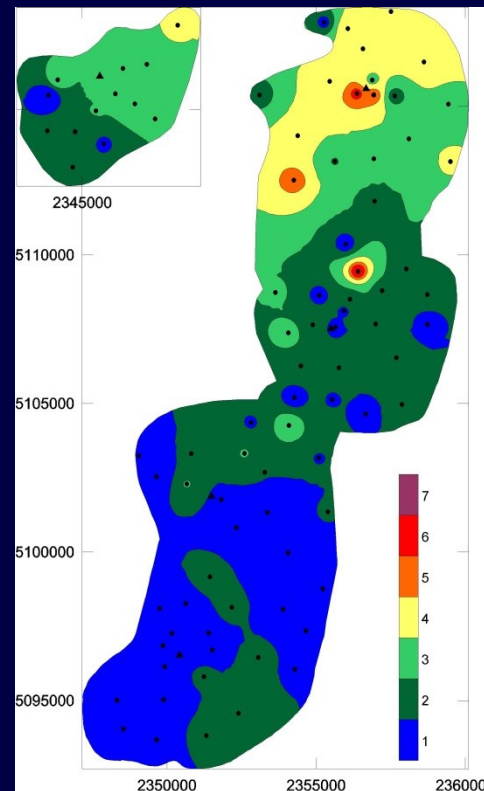
Biomonitors & friends...

Systematics
Ecophysiology
Biomonitoring

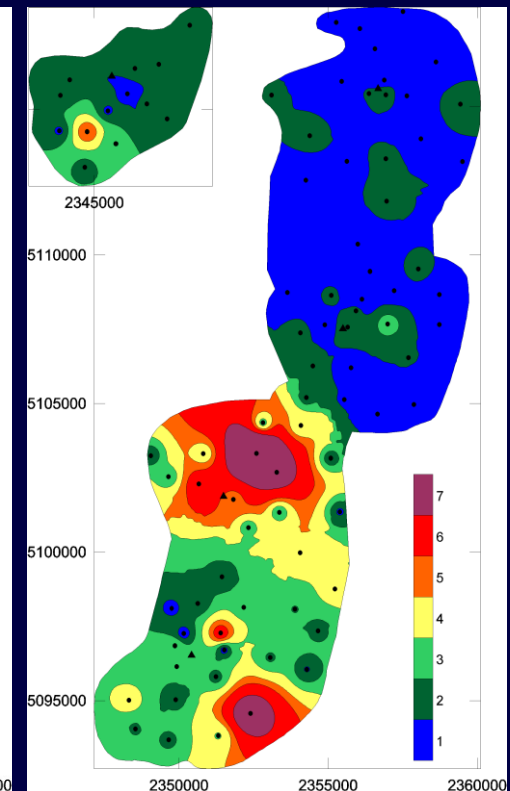


With native and transplanted cryptogams it is possible to get in short times, at low cost, and with a high sampling density, distribution maps of airborne persistent pollutants, e.g. trace elements, such as mercury (left) and copper (right).

Mercury



Copper

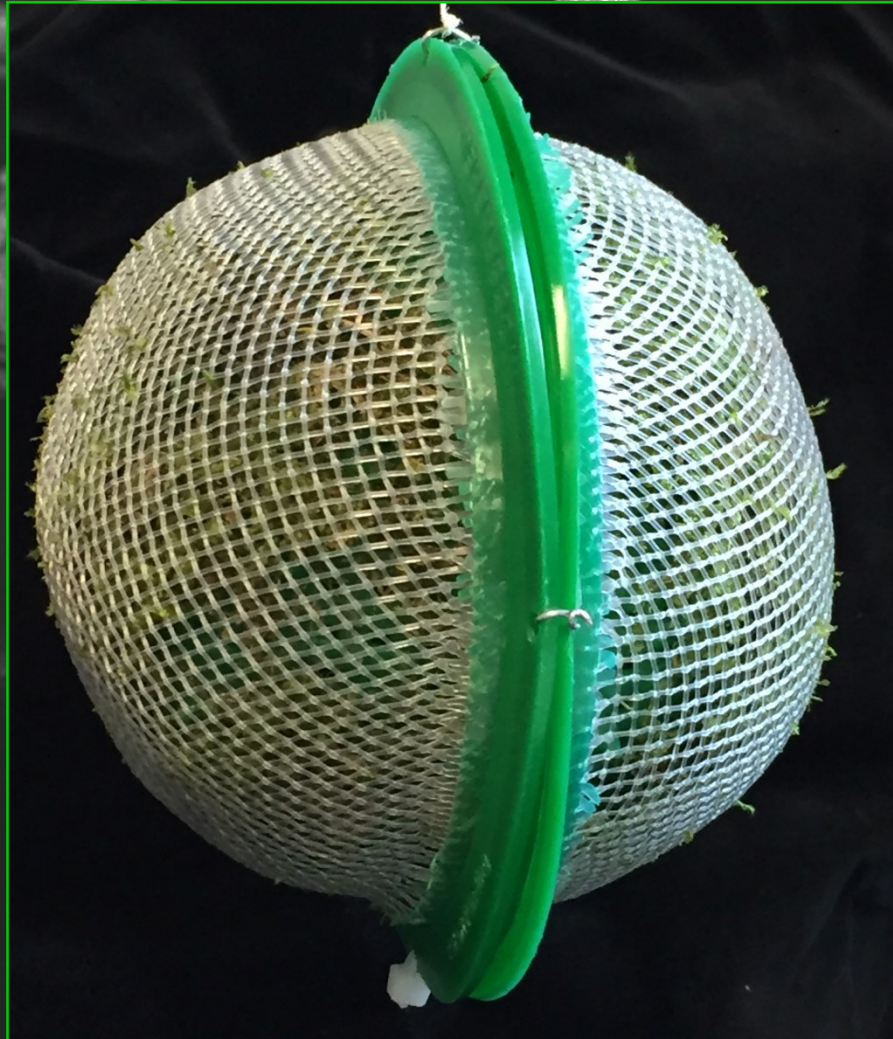


Biomonitors & friends...

Systematics
Ecophysiology
Biomonitoring



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...this small ball, made of a plastic net, contains a moss or lichen sample. It is used to measure trace metal and PAHs deposition in areas where native mosses and/or lichens are missing.

In the last five years we promoted and carried out:

- A project aimed at defining *background* values at national level for a lichen frequently used in transplants;
- Standardisation of new protocols for the use of lichens as bioaccumulator of potentially toxic elements (PTE).



Last year we worked for establishing the new **International Association for Biomonitoring of Environmental Pollution – IABEP**.

The fundative congress was held here in Trieste, with the students invited to participate (!).

The 2024 IABEP congress will be held in **Lisbon, Portugal**, in November.

IABEP 2023 (11-13 October 2023)

[Home](#)

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[IABEP](#)

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comune di trieste

Organized with the contribution of



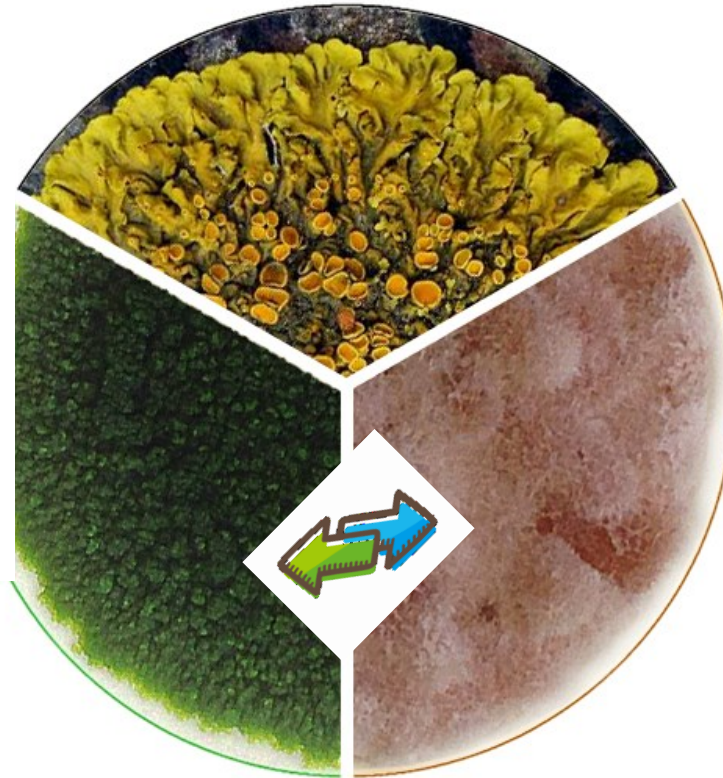
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Dipartimento di
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Base research: Lichens = symbiosis between a algae (or cyanobacteria) and a fungus



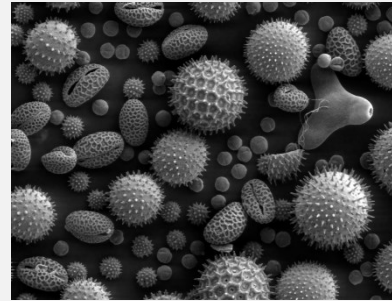
First symbiosis ever described – still little knowledge on the «lichenization» process (transition from a free-living to a symbiotic state) - What chemical interactions trigger and drive this process?

Desiccation tolerance

«Ability to survive **complete desiccation** (< 10% water content) and return to a normal metabolism when water is newly available»



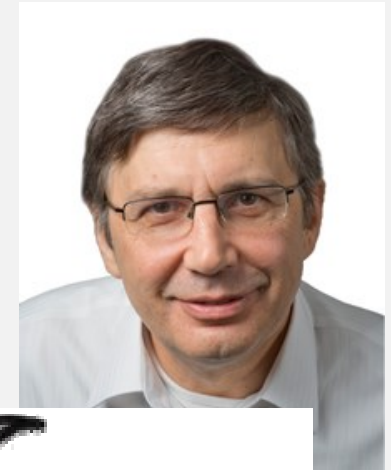
Typical of species, (phylogenetically distant) that thrive in macro- or micro-environments characterized by scarce or unpredictable water availability, or of developmental stages such as pollen, seeds or larvae



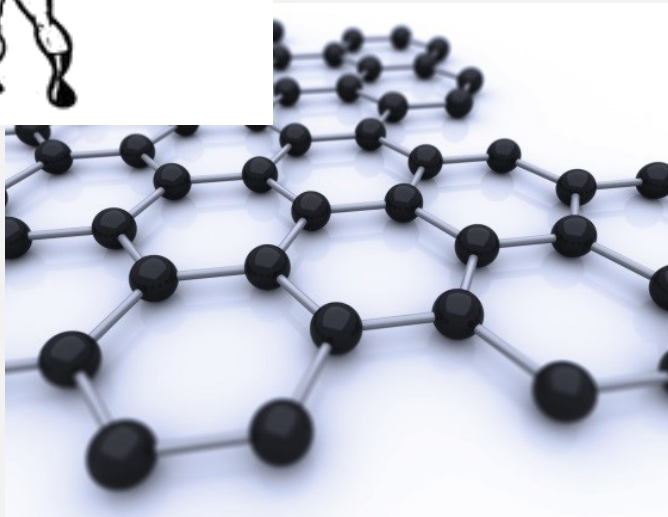
Can live almost everywhere: extremotolerant and extremophilous



Applied research => Environmental impact and fate of Graphene



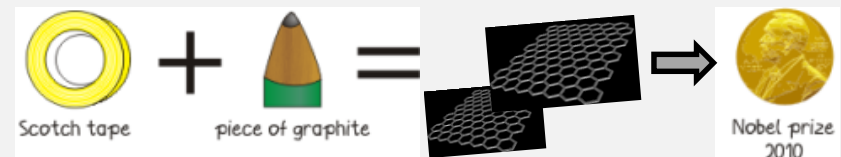
What is graphene?



“A two-dimensional crystal composed of monolayers of carbon atoms arranged in a honeycombed network with six-membered rings.”

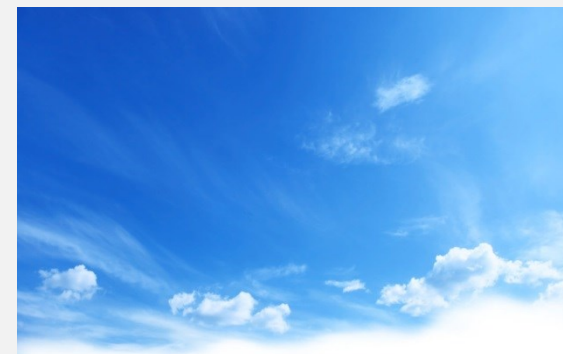
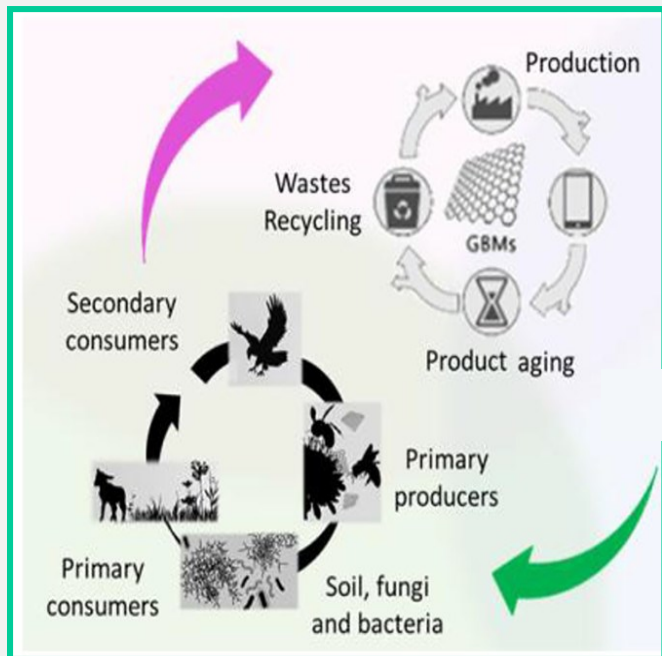
Geim, AK (2009) Science. 324: 1530-1534

2004 – extracted the first monoatomic layer



Thanks to the **extraordinary chemical–physical properties** graphene can be applied to a wide range of applications

Graphene life cycle and possible fates



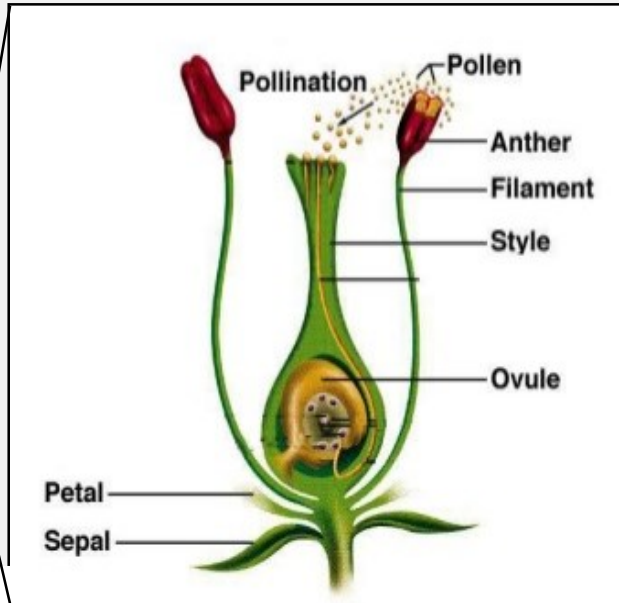
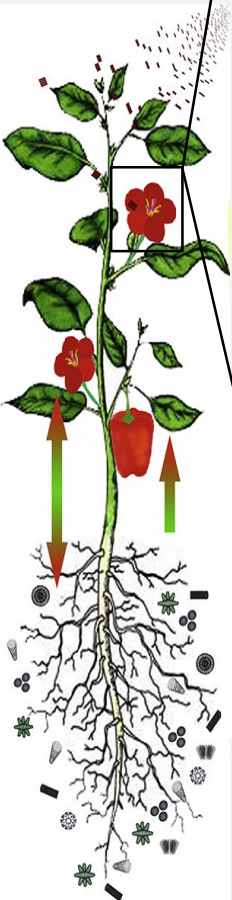
ACS Nano 2018, 12, 10582–10620

POTENTIAL EMERGING POLLUTANT

Environmental impact: Graphene effects on seed plants

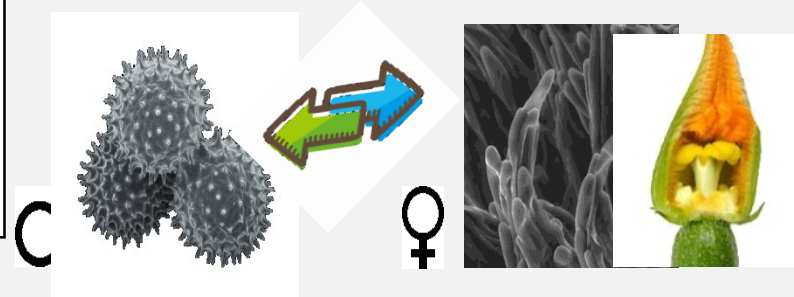
Impacts of carbon nanomaterials (CNMs)

Seed germination, plant growth, development, toxic or no responses



Sexual reproduction of seed plants:

- ❖ It is a delicate process
- ❖ xenobiotic substances can impair it



Aim: verify if GRMs can affect the sexual reproduction of seed plants

Environmental fate:

Biodegradability of GRMs

Do GRMs get degraded in terrestrial environments by primary decomposers?

Basidiomycetes
(white rots)



Bjerkandera adusta

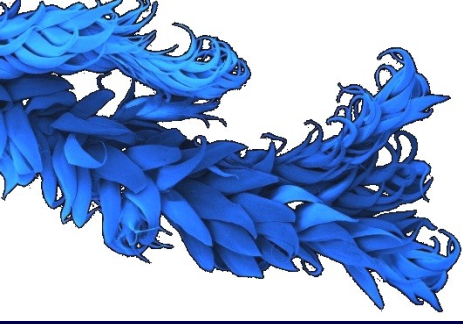


*Phanerochaete
chrysosporium*

Ascomycete



Morchella esculenta



Now it's your time to tell something on your CV...

Our questions are:

- (a) How many are from UniTS, how many from other Univs.;
- (b) How many biologists, and how many naturalists, how many «others...»;
- (c) Your knowledge on specific matters, such as Environmental chemistry; Environmental law; «Geology and related matters» etc...
- (d) Special interests, with emphasis on (i) phenomena; (ii) groups of organisms (ex. vascular plants, birds, insects, Nematoda...); (iii) readings and social activities.
- (e) Thesis.

How we judge this environmental change?

Monte Babiza 



Monte Grisa 



Alteration of the natural composition of the environment and its resources by anthropic action

POLLUTION



Visible the change invisible the
cause



Changes in species spatial distribution
and abundance or disappearance and
death are the symptoms of changes in
their ecological niche

Acid rains by SO_2 and NO_x release

Land use and urbanization



Environmental change usually has a negative meaning

Environmental pollution



Climate change

