

Cover Page for Final Conference Paper

Name of Institution: J. Craig Venter Institute

Award Number: DE-SC0012104

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Project Title: "EU-US Working Group on Environmental Biotechnology Short-Course"

Project Period: (06/15/2014-06/14/2015)

Introduction

As we enter the 21st century, the sustainability of the biosphere is a global challenge that can best be met with a global response. This includes how we train and promote our next generation of research scientists in the emerging arenas of genome-enabled biology and a bio-based economy. It is this fundamental issue that has formed the motivation for designing and conducting a shortcourse entitled “FACILIS 2014: Microbially-driven facilitation systems in environmental biotechnology” (hereafter “FACILIS”) presented here by the European Commission (EC)-United States (US) Task Force on Biotechnology Research.

The Working Group was established in 1994 under the umbrella of the US-EC Task Force on Biotechnology Research, a transatlantic collaborative group overseen by the US Office of Science and Technology Policy (OSTP) and the EC. The Environmental Biotechnology Working Group maintains several goals, including establishing research links between scientists in EU countries and the US and fostering the careers of junior scientists from both sides of the Atlantic to the global nature of scientific cooperation.

The EU-US short courses have as a mission "To train the next generation of leaders in biotechnology to work collaboratively across the Atlantic". The philosophy is that, if collaborations can be started early in a scientific career, they can last a lifetime.

The European members of the Working Group are:

Spiros Agathos, University of Louvain, Belgium

Jens Hoegel, EC

Ivonne Nijenhuis, UFZ, Germany

Balbina Nogales, University of Balearic Islands, Spain

Juan Ramos, CSIC, Granada, Spain

Jan Roelof van der Meer, University of Lausanne, Switzerland

Herman van Mellaert, EC

The US members of the Working Group are:

Todd Anderson, US Department of Energy

Daniel Drell, US Department of Energy

Kelly Bender, Southern Illinois University

Barbara Methé, J. Craig Venter Institute

Judy Wall, University of Missouri

Lily Young, Rutgers University

Gerben Zylstra, Rutgers University

The Working Group has successfully conducted symposium-style environmental biotechnology workshops designed to bring together junior and senior people in an atmosphere conducive to collaborative discussion. Over the last seventeen years the Working Group has held short courses on environmental biotechnology at Rutgers University, CSIC in Madrid, the University of Oklahoma and the University of Lausanne.

Following a similar pattern to sponsoring previous Working Group educational efforts US support was sought for i) tuition and travel expenses for ten US students who participated in the course, and ii) travel expenses for four US faculty who lectured in the course. Separate support was provided by the European Commission to support travel expenses for an additional students and faculty members from EU countries to attend and/or lecture in the short course.

Figure 1. DeFENS building, site of lectures and laboratory activities.



Course Background

The course was sponsored by the EU-US Working Group on Environmental Biotechnology and held at the University of Milan in Italy on July 12-25 2014. Students with backgrounds in microbiology, microbial and molecular ecology and environmental sciences were invited to apply for participation at the

course, through advertising on the websites that included microbiology societies such as FEMS, ASM, and other National Societies. Qualified applicants were selected based on a thorough review by the Working Group.

The FACILIS short course was hosted and organized by Daniele Daffonchio and Sandra Borin at Milan in cooperation with the Working Group. The course was organized around cross-cutting themes and designed to attract a stellar group of interdisciplinary early career researchers. The course provided them with hands-on experience with the latest scientific methods; using a format that combines lectures, laboratory research and field work with the final goal to enable researchers to finally turn data into knowledge. The course was held at the Department of Food, Environmental and Nutritional Sciences (DeFENS), University of Milan (UMIL) (**Figure 1**) which is a public, multidisciplinary teaching and research institution. The study of microbial communities and their interaction with their environment was a central theme of the course. One

Figure 2. Greenhouse facilities at the Faculty of Agriculture, where experiments with plants were organized.



of the areas in which this effort was undertaken was in the study of microbial communities associated with plants with a goal of understanding how this information can be used towards the development of agricultural biotechnologies (**Figure 2**). Molecular ecology, genomics and metagenomics tools were employed in addition to standard microbiology techniques for this purpose

Course outline

The course involved 22 students, 10 from the US and 12 from the EU. The laboratory work was organized by dividing the students in groups of three, taking care to obtain mixed backgrounds, country of provenance and their level of PhD or Post-Doctoral experience. Each student was given the opportunity to present his or her own research during evening lectures, promoting exchange of experience and multidisciplinary discussion. The final sessions of the course were dedicated to discuss the scientific results obtained during the course. Working groups were established with students of the course along with DeFENS Staff Scientists to aid in data analysis and interpretation and to prepare a report summarizing the course experimental results and discuss the course experience.

The course covered the topics of

- i) microbial ecology, especially applied to the study of phylogenetic and functional diversity of natural bacterial assemblages by the application of molecular and metagenomic methodologies
- ii) host-bacteria relationships, in particular related to the microbial communities associated with plant roots and biodegradation of pollutants
- iii) the biotechnological exploitation of plant symbionts for promoting plant growth in agriculture and soil phytoremediation practices.
- iv) comparisons of microbial communities from, and interacting in, different environments including soil, water, humans and the built environment

The laboratory activity were supported and complemented by lectures given by internationally recognized experts from academia and industry who covered all the above mentioned research topics with the addition of a lesson about scientific writing (**Figure 3**). Two field trips completed the scientific program, i) in the city of Brescia to an industrial polluted field and the headquarters of the Regional Agency for Services to Agriculture and Forests that has the task of site remediation, where a lesson about pollutant fate and pollution modelling took place, and ii) a visit to the molecular ecology laboratory of the European Commission, organized by Dr. Teresa Lettieri at the Joint Research Center (JRC) in Ispra, Italy.

Finally, several cultural events were organized in the city and in its surroundings to encourage student interaction and exchange of their own experiences. These included a night guided tour to the Milan city center, a hiking tour in the mountains above the Lake Como and a gala dinner in a restaurant in Milan center.

A Facebook page was established (<https://www.facebook.com/groups/542023595920319/>) to share pictures and get together all the participants, while a dropbox folder was shared to distribute among all the participants a) speaker presentations, b) course presentations, c) results of the experiments.

Figure 3. A summary of the approximate course schedule.

time/day	Day 1 - Sat 12	Day 2 - Sun 13	Day 3 - Mon 14	Day 4 - Tue 15	Day 5 - Wed 16	Day 6 - Thu 17	Day 7 - Fri 18			
9:00	arrival	introduction to labwork	DGGE gel prep	DGGE gel staining, band cut and amplification	check of PCR of degrading genes, PCR on isolates for 16S and degrading genes	pyrotag metagenomics data analyses	Lecture	ARISA & DGGE result stat		
10:00		rhizosphere sampling and biphenile degrading bacteria isolation					ARISA PCR		Lecture (M. FERRER)	Lecture (B. METHE)
11:00		lunch	lunch			lunch				
12:00		rhizosphere DNA extraction and PCR-DGGE	pyrotag metagenomics intro & analyses	DNA extraction from previously isolated pure strain	field trip to caffaro PCB contaminated site	qPCR of degrading genes	metagenomic analyses			
13:00				PCR of i) degrading genes on rhizosphere and isolates, ii) 16S on isolates						
14:00				check of ARISA PCR on agarose						
15:00				Start of DGGE run						
16:00				Opening Lecture (G. BERG)						
17:00		get togheter cocktail	Lecture (J. PETT-RIDGE)	Lecture (G. TSIAMIS)	Lecture (J. Zehr)	dinner	dinner	gala dinner		
18:00		dinner	dinner	dinner	dinner					
19:00		student lectures		student lectures	Milan guided tour	student lectures				
20:00										
time/day	Day 8 - Sat 19	Day 9 - Sun 20	Day 10 - Mon 21	Day 11 - Tue 22	Day 12 - Wed 23	Day 13 - Thu 24	Day 14 - Fri 25	Day 15 - Sat 26		
9:00	strain genetic transformation	hiking excursion	Lecture	travel to JRC	Lecture (N. WEYENS)	microscopic analyses of plant colonization	paper outline brainstorming	departure		
10:00			PCR for metal resistance genes in rhizosphere and isolates	interactive lectures: DNA microarray and metagenomics (T. LETTIERI)	exane extraction of PCB fom cell incubation and plant leaves		working groups			
11:00										
12:00	lunch		lunch	lunch	lunch	lunch				
13:00	lecture: scientific writing (A. HOOGENKAMP-O'BRIEN)		PGPR tests of isolates	Visit to NanoScience lab	check of PCR on metal resistance genes	Lecture (N. Lewis)	working groups			
14:00				transfer by ferry to Borromee islands (lake Maggiore), visit and dinner	PGP test in vivo on Arabidopsis (test on metal tolerance)	free time to finish experiments				
15:00	inoculation of isolate cells on PCB mix		Arabidopsis root colonisation by GFP labelled isolates		Closing Lecture (N. KALOGERAKIS) & end of the course					
16:00			result discussion and workign groups for figure preparation		dinner	dinner	dinner			
17:00	student lectures			student lectures						
18:00										
19:00	free time									
20:00										
COLOUR LEGEND										
Lectures			student presentations and working groups			field trip and visits to laboratories				
lab activities			travels, lunches and dinners			social/activities				