ENVIRONMENT AREA

Project code: PJ10 AM 01

The role of microRNAs in Ljungan virus infection

HEIDI HAUFFE – AZEDDINE SI AMMOUR

Partner Institution: Università di Trento - CIBIO Trento (ITALY)

Scientific objectives

Rodent-borne RNA viruses are becoming increasingly widespread, causing serious human disease across the globe (www.ecdc.europa.eu), including Trentino. A newly discovered RNA picornavirus, the Ljungan virus (LV), is of particular interest since this pathogen has been associated with diabetes, myocarditis and/or gestational abnormalities in both rodents and humans. LV has recently been found to be present in rodent species in Northern Italy. Given the potential global impact of this virus, one important avenue of research should include the control of infection. In this project, the PhD student will use bioinformatic and advanced molecular methods (next generation Illumina and 454 sequencing and real time quantitative PCR) to test the hypothesis that LV generates pathogen-specific miRNAs to promote replication and/or evade host adaptive immunity. This project will be carried out primarily at the Fondazione E. Mach in close collaboration with and including an external placement in the Laboratory of RNA Biology and Biotechnology, CIBIO, University of Trento, Italy (PI: M. Denti). The eco-epidemiology of LV may also be pursued and other short external placements may be possible depending on the student's interests and preliminary results of the project.

This is a challenging and ambitious project and requires a dedicated and enthusiastic student with experience in molecular biology. The PhD candidate will be working with two research groups within the Fondazione E. Mach: the FEM-EcoHealth group (Leader: A. Rizzoli; PhD supervisor: H. C. Hauffe) and the GenReg group (Leader and PhD supervisor: A. Si-Ammour). The FEM-Ecohealth group is currently involved in several EU-wide projects on emerging zoonoses, and has been studying rodent-borne disease for more than a decade, with expertise in field experiments, epidemiological molecular methods and disease statistics and modelling. LV was discovered by members of the FEM-EcoHealth group for the first time in Italy in 2006 and since then, various avenues of research on this virus have been pursued in close collaboration with colleagues in Sweden and the USA. The GenReg group is involved in post-transcriptional based mechanisms and miRNA discovery with expertise in both computational and experimental methods applied to small RNAs.

Research group

The FEM-Ecohealth group is currently involved in several EU-wide projects on emerging zoonoses, and has been studying rodent-borne disease for more than a decade, with expertise in field experiments, epidemiological molecular methods and disease statistics and modelling. LV was discovered by members of the FEM-EcoHealth group for the first time in Italy in 2006 and since then, various avenues of research on this virus have been pursued in close collaboration with colleagues in Sweden and the USA. The GenReg group is involved in post-transcriptional based mechanisms and miRNA discovery with expertise in both computational and experimental methods applied to small RNAs.

Project code: PJ10 AM 02

Partial migrations in ungulates to assess ecosystem response to global changes

CAGNACCI FRANCESCA

Partner Institution: College of Forestry and Conservation, University of Montana (USA)

Scientific objectives

1) To identify determinants of partial migratory behaviour in mountain ungulates.
2) To model movement behaviour and social relationships of partially migrating ungulates (migrant and resident individuals), under different climatic conditions, resource availability and predation pressure.
3) To predict patterns of movement of partially migrating ungulates under different scenarios of climate change and snow-cover in mountain environment.

Statement of the research problem

Breakthroughs in *evolutionary ecology* require long-term datasets acquired from longitudinal monitoring of recognizable individuals of model species to validate the theoretical framework using empirical data. Life-history and behavioural traits respond to the selective pressure which specifically characterizes each environment, in terms of resource productivity, predation pressure, inter-specific competition, diseases and climate. Fast-occurring climatic and human-induced changes force behavioural and physiological traits of species that lead to *ecological plasticity*. Seasonal *partial migrations* in ungulates is particularly subject to changes affecting spatial and temporal use of resources (Hebblewhite *et al*. 2006; Hebblwhite *et al*. 2008). As such, not only they represent the ideal natural setting to understand the evolutionary and ecological causes of migratory behaviour: partial migrations offer a unique opportunity to examine *ecosystem resilience* to climate and global changes *with an evolutionary perspective*. The final, exciting fall-out would be to predict species responses under different future scenarios of climate and habitat change.

Methods

The main empirical approach will consist of modelling migratory movements and space use of individuals marked with VHF and GPS collars (Cagnacci et al. 2010). Trajectory and movement modes will be analysed at multiple spatiotemporal scale with stochastic modelling, GAMMs and ACFs (Fryxell et al. 2008). Resource use will be assessed, at difference spatial scales, by RSFs and GLMMs. Social relationships will be modelled with Social Network Analysis (Perkins et al. 2009). Model species could include roe deer *Capreolus capreolus* and red deer *Cervus elaphus* in Europe and caribou *Rangifer tarandus,* bighorn sheep *Ovis Canadensis*, elk C*ervus canadensis* and pronghorn *Antilocapra americana* in North America. Data from novel individuals captured and marked will be used, along with existing datasets from different areas, such as those encompassed in the EURODEER collaborative platform (http://sites.google.com/site/eurodeerproject/). The behavioural ecology data will be coupled with climatic variables and large scale/high resolution data referred to landscapes obtained by remote sensing and remote imaging, and by local surveys. Local availability of food resources in winter in some sampling areas will be experimentally manipulated installing winter feeding stations, and animal behaviour assessed in detail with the aid of Wireless Sensor Networks.

Research Group

Francesca Cagnacci is confirmed researcher at Edmund Mach Foundation, Research and Innovation Centre, Environent and Natural resources area. Her main interest is behavioural ecology of mammals, with emphasis on ecological determinants of animal movement, social interactions, resource use, and host-parasite dynamics. With her numerous PhD and Ms students, as well as her wide international network, she has focused on community and population ecology, by means of individual tagging of animals with bio-logging devices, video-surveillance, Capture Mark Recapture and Distance sampling designs, statistical and spatial modelling. She has pursued her specific interest on technological advances for animal ecology studies, including Bio-logging (GPS telemetry and Wireless Sensor Networks), and Best Practice Wildlife data management, organising international workshops (Challenges and opportunities of using GPS-based locations in animal ecology, http://rstb.royalsocietypublishing.org/site/2010/GPS.xhtml ; Bio-logged data management and sharing, http://www.cmar.csiro.au/biologging4/workshops.htm) and designing and developing the Research Network EURODEER (http://www.eurodeer.org); in the latter context, she has studied partial migrations in European roe deer.

The PhD candidate will spend part of its studentship at the Ungulate Ecology Lab of University of Montana (Prof. Mark Hebblewhite, http://www.cfc.umt.edu/Heblab/default.html). The research interests broadly lie in understanding 1) how wildlife such as ungulate herbivores balance the costs of predation with the benefits of foraging, and 2) how human activities influence this balance, and the ensuing conservation and management consequences to wildlife population dynamics. Specifically, Prof.

Hebblewhite and the lab members are examining the ecological and genetic aspects of ungulate migration in woodland caribou, moose, pronghorn antelope, elk and endangered Sierra Nevada Bighorn sheep. Understanding the responses of these important ecological species to climate change, and how they adapt their migration patterns to a changing climate, are critical pieces understanding ecosystem responses to climate change. The Ungulate Research Lab approach is largely empirical, based on field studies, and makes use of advances in spatial and statistical modeling including resource selection functions, cox-proportional hazards survival analyses, and landscape simulation models using GIS.

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Project code: PJ10 AM 03

Evolution of regulatory elements of adaptive genes in Conifers

VAROTTO CLAUDIO

Partner Institution: University of California at Davis - Department of Plant Sciences (USA)

Scientific objectives

The aims of this project are:

1) the identification of regulatory elements (RE) in the promoters of 3 genes involved in adaptive responses in conifers;

2) the analysis of patterns of RE nucleotide variation in conifers;

3) the assessment of the adaptive potential of polymorphisms affecting the RE identified in natural populations of selected conifer species.

Statement of the research problem

Conifers are extremely important tree species, both from an ecological and an economical point of view. Several candidate genes for stress adaptation have recently been identified in conifers or characterized in model species. While most of the studies currently focus on the identification of signals of selective pressure acting on the coding sequences, little is known about regulatory regions. We are looking for a highly motivated and dynamic candidate to carry out a PhD project aimed at the identification of regulatory elements (RE) in the promoters of genes involved in adaptive responses in conifers. Natural genetic variation affecting the regulatory elements identified will be assessed in natural populations of selected conifer species and associated to adaptive differences among them.

Expression levels of the candidate genes will be correlated with stress sensitivity and stress resistance among conifer species. At the population level, the identification of nucleotide variations in the REs identified will allow to screen for natural variations of candidate gene expression levels in selected species by means of a “reverse ecology” approach. Population genetics studies will then provide the framework for the statistical identification of naturally occurring regulatory variation in adaptive genes in selected conifer species.

The project will be carried out at the Edmund Mach Foundation (http://www.iasma.it/), in collaboration with the group of Prof. David Neal (http://dendrome.ucdavis.edu/NealeLab/). The successful candidate will carry out at least 6 months of the project at the University of Davis, California (USA).

Methods

Statistical identification of RE from conifer species (collaboration with DB Neale, UCD). Determination of selective pressure acting on RE. Correlation of nucleotide variations in RE with adaptive traits in natural conifer populations (collaboration with DB Neale).

Research group

The long-term commitment of our group is the understanding of the molecular bases of plant biodiversity generation and maintainance in natural and semi-natural environments. In particular, we are interested in the evolution of adaptive responses to abiotic stresses. Currently our projects focus on the comparison of adaptive mechanisms in congeneric species with different ecological preferences with respect to elevation and their ability to cope with low temperature. We approach this biological question with a series of tools ranging from the in-house development of universal markers for sound reconstruction of the phylogeny of the species we are studying to the application of high-throughput sequencing for the discovery of genes under positive selective pressure in different plant species. In an attempt to provide an olistic view of the adaptive mechanisms underlying biodiversity generation, we are developing new approaches for the identification of regulatory elements to understand the role of gene expression regulation in plant adaptation.

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Project code: PJ10 AM 04

Role of fungal pathogens in driving forest ecosystem evolution under climatic change effect

LA PORTA NICOLA

University of Helsinki (FINLAND) and Norwegian Forest and Landscape Institute (NORWAY)

Scientific objectives

The objectives of this research are to evaluate the ecological impacts of climate change on the utilization of European forests. The primary objectives of this project are linked to estimating the adaptation of trees to climate change, exploring new innovations that could be applied in forest and environmental management. Climate change will affect the nature of pathogens (fungi and insects). Increased temperature implies that host resistance to disease may be overcome more quickly as a result of rapid disease cycles. For fungal pathogens, warmer temperatures will be suitable for accelerated growth and reproduction. Increased temperature will also potentially lead to expansion of a range of diseases from warmer countries. To mitigate the impacts of climate change, understanding the factors that trigger development of forest tree disease epidemics will be essential. By employing in vitro experimental conditions with the aid of novel biotechnological tools, we are able to identify potential indicators of climate change among pathogens as well as possible genetic effects (changes in phenotype or in gene expression) of climate change on pathogens. The studies will primarily focus on the following questions: 1) How do the gene expression profiles change in elevated temperature 2) How does the magnitude of phenotypic variation in resistance traits among tree genotypes change in

variable environmental conditions 3) How do mycorrhiza and endophytic fungi/bacteria contribute to resistance of forest trees against specific pathogens in changing climate?

Statement of the research problem

Climate change in the form of increased temperature, carbon dioxide concentration and precipitation will affect the whole forest ecosystem including both above and below ground micro-biota. Understanding the traits necessary for forest trees to tolerate environmental stress will be essential for the creation and implementation of effective strategies and policy to mitigate the effects of climate change. New technologies including recent advances in biotechnology will help in understanding the molecular basis of adaptation, and provide tools for environmental management. Pest and disease resistance are strongly influenced by environmental conditions, and the role of pathogens in modifying plant population and community structure could become more important in future because warmer temperatures may allow longer periods for pathogen attacks.

Methods

The main research methods include controlled cultivation of conifer trees genotypes under varying selection pressures (temperature, CO2 level, moisture, biotic factors). Trees are also grown in stressed soils in normal and elevated temperature. Pyrosequencing and micro-array transcript profiling technology will be used to investigate genetic effects of changing climate to forest tree pathogens. Phylogenomics approach will be used to study adaptive traits in key pathogens and to identify potential genes that might be under selection pressure in changing climate.

Research group

The group REINFORS – Response indicators of natural and seminatural forest ecosystems to environmental stresses - is mainly focused on forest ecology and stressors and it is composed by 8 members of staff. Our group is approaching this topic with a series of studies. Some of the studies carried out by our group are: Measurements and modelling of tropospheric ozone concentration and exposure and analysis of the potential risk for semi-natural and natural vegetation by experiments in controlled environmental conditions like ozone fumigation in mini Free-Air fumigation systems; Selection and use of plants, lichens, macromycetes and opportunistic soil pathogens as climate and pollution bioindicators; evaluation of the indicators responses (morphological and physiological parameters) along natural gradients of pollutants; Isotopic approaches to evaluate past climatic factors fluctuations like temperatures (O18, D) and drought (C13, N15) on tree rings; Gene expression and characterization of the genomic and proteomic molecular basis of the biotic and abiotic stressors under CC conditions; Study genetic population structure of high virulent old forest pathogens and new alien pathogen introductions to forecast they behaviour under CC conditions; Mitigation of the deleterious effects of CCs by mean of both epidemiological approaches and biological control methods of the

pathogens; Development of DNA based diagnostic methods for the detection and quantification of latent and asymptomatic pathogen microorganisms. This PhD project, based at FEM, will be held in cooperation with other two research groups at the University of Helsinki and at the Norwegian Forest Research Institute at Ås with whom we built a strong and fruitful cooperation along last years.

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Project code: PJ10 AM 05

Global changes and arboviral diseases emergence (VB)

or

The effect of climate on host-parasite interactions (RB)

RIZZOLI ANNAPAOLA

Partner Institution:

(VB) Faculty of Veterinary Medicine, University of Torino (ITALY); School of Veterinary Medicine, University of Wisconsin-Madison (USA) and Department of Environmental Studies, Rollins School of Public Health, Emory University (USA)

(RB) Cardiff School of Biosciences, Cardiff University (UK).

Scientific objectives

1) **VB**. To investigate the eco-epidemiology of West Nile virus and other Flaviviruses in northern Italy;

2) **RB**. To determine how the parasite community of wild rodents changes in response to climatic conditions at different altitudes; in particular to quantify the social network of rodents at differing

altitudes; to determine the immunogenetic variation within hosts across an altitudinal gradient; to determine the response of hosts to novel parasites, using common garden experiments.

Statement of the research problem

At global scale, humanity is experiencing a period of unprecedented infectious disease emergence. Nearly half of all human infectious diseases known today can be classified as emerging where the majority have jumped from animal populations into humans (zoonosis). As driving factors, the effect of biodiversity loss and climate change are now included among the research priorities in this field at global scale. Diseases transmitted by arthropod vectors (ticks and mosquitoes) and wild rodents are particularly relevant for northern Italy. Our research proposal will focus on two particular disease systems. The first (**VB**) will study the eco-epidemiology of West Nile virus and other emergent flaviviruses in northern Italy combining advanced molecular and eco-epidemiological studies. The second (**RB**) will focus on particular aspect of host-parasite interaction in wild rodents at various altitudinal gradinet. This research project will examine the evolutionary and ecological impact of global climate change on both the host (rodent) and their parasites.

Methods

VB. Data and samples collection of vectors and hosts in both endemic and non endemic regions; molecular detection of arboviruses and phylogenetic analyses; statistical and mathematical models

RB. Replicated transects along an altitudinal gradient; rodent live trapping and biological samples collection; parasitological and molecular lab analysis; statistical and mathematical models

Research group

This project required a highly motivated student who will share with us and our partners our ambitious research programmes within an Eco-health perspective (www.ecohealth.net). This is an innovative research approach which extends traditional environmental health by studying the relationship between health and specific ecological factors, such as climate change, biodiversity loss and ecosystem function. Our current research projects are focused on the ecology and epidemiology of vector borne and rodent borne diseases in the Alps, which also represent emerging health threats at a European level, such as Lyme disease, tick borne encephalitis, West Nile disease, and rodent- borne diseases (ROBO) such as those caused by Ljungan and Arena virus infection. The FEM-Eco-Health group collaborates with many other leading institutions, from Italy, EU and around the globe, and participates in collaborative research programs funded by the Autonomous Province of Trento (ACE-SAP project www.ace-sap.it) and the EU (see EDEN www.eden-fp6project.net).

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Project code: PJ10 AM 06

Sustainable Carbon sequestration using Biochar

MIGLIETTA FRANCO

Partner Institution: DISA, Università di Udine (ITALY)

Scientific objectives

The project aims to answer a series of questions that define its objectives:

How do different feedstock affect the C-stability in the short term?

Does Biochar have any potential toxic effect on plants?

How much carbon can be sequestered in realistically using biochar ?

How stable is Biochar in soils exposed to intensive management and periodic ploughing?

Statement of the research problem

The search for meaningful ways to transfer carbon from the atmosphere via biomass into useful carbon deposits is currently a key challenge. Transferring biomass to carbon-rich materials with potential mega-scale application is a material option to sequester carbon from plant material, taking it out of the short-term carbon cycle and therefore binding CO_2 efficiently and even in a useful, productive, way into longer term non-atmospheric carbon pools. There are several ongoing efforts aimed at reducing greenhouse gas emissions through sequestration of carbon. One promising but simple option is to obtain carbon sequestration by increasing the amount of carbon in agricultural soils. But recent analyses urge caution, highlighting that very often the efforts aimed to achieve C sequestration in soils are offset by other greenhouse gas emissions and that soils generally show low potential to accumulate C. In addition, soil organic matter remains vulnerable as it can be decomposed rapidly if management

practices that favours C-accumulation in the soils are not maintained in the long-term. One of the most interesting alternatives for long-term C-sequestration in soils is to transform biomass, and in particular residues, into a stable product (Charcoal or Biochar) that cannot neither be decomposed by soil microorganisms nor be oxidised and then returned to the atmosphere in the form of CO_2.

Methods

The activity planned in the laboratory has three aims, (i) to explore and assess the physical-chemical-biological properties of Biochar, (ii) to investigate the long and short-term stability of Carbon contained in Biochar and (iii) to quantify the toxicity of different Biochar feedstock into ecosystems using model mesocosms and the model plant, Arabidopsis and its mutants that has a fast life cycle. The project will focus predominantly on two types of Biochar obtained from different feedstocks. In the first instance, the workplan will involve basic surveys to be made for the many different sorts of Biochar and the measurement of their differentiating physical-chemical properties. The mechanisms leading to Biochar stabilization in soil are in fact supposed to be associated to its spatial organisation in aggregates but very little is known about the stability (recalcitrance) of derived chars. The assessment of C-stability in Biochar will be approached using stable isotope C-labelling techniques that will allow to monitor respiratory processes occurring in Biochar exposed to decomposing agents and by investigating short vs long-term stability using charcoal samples collected in a network of archaeological sites.

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Project code: PJ10 AM 07

Forest modelling

SOTTOCORNOLA MATTEO

Partner Institution: Civil and Environmental Engineering Department, University College Cork (IRELAND) and Dipartimento Colture Arboree, Università di Bologna (ITALY).

Scientific objectives

The main objective is to predict on the medium-long term the dynamics driving the climate-biosphere interactions, with special regard to forest ecosystems. To understand the effects of climate change on the agro-forest ecosystems, it is necessary to develop and parameterize detailed physiological models that simulate processes of mass and energy exchanges (solar radiation, carbon dioxide, water, nutrients) in the main ecosystem components (soil, vegetation and atmosphere). The SVAT models can simulate the carbon (photosynthesis, respiration, C and N allocation, litter decomposition) and water (evaporation, transpiration, water transport) cycles at daily to decadal time scales, by integrating the physiological and ecological mechanisms driving these processes.

Statement of the research problem

SVAT models simulate the processes of carbon cycle (photosynthesis, respiration. C and N allocation, litter decomposition) and water cycle at daily to decadal time scales. These models can include different plant functional types with different physiological (C3 or C4 photosynthesis), phenological (deciduous, evergreen), and physiognomic (tree, grass) characters, based on bioclimatic limits for the plant growth and regeneration, and on plant specific parameters that govern plant competition for light and water.

Methods

The ecophysological responses to climate changes by the vegetation in the region will be analysed using specific biogeochemical models. These models will synthesis the processes occurring at different spatial scales in an ecosystem. The physiological processes occurring in the leaves will be quantified and integrated with measurements of canopy reflectance from aircrafts or satellites, after verification and calibration of the remote sensing products with ground measurements of plant canopies architectural and physiological characters. At the regional scale the activity will deal with the specific problems of remote sensing in mountainous areas, with the aim of developing advanced methods in automatic classification and biophysical parameters estimation (GPP, NPP, evapotraspiration, etc).

Research group

Research activities of the forest ecology group are focused on the interactions between the vegetation canopy and the atmosphere chemical-physical layer and consider also the soil structure and functionality. In particular, energy and matter (carbon, water, nitrogen) fluxes between the atmosphere and the biosphere are analysed and models simulating vegetation systems and turbulent and radiative transfer are used. These data are up-scaled at a regional level to obtain a carbon balance integrating ground and remote sensing data bases. The interdisciplinary study on the interactions between vegetation, soil and climate is carried out also analysing the soil-canopy interaction. These activities are

organized within two EU projects (DG Research, VI and VII framework, respectively NITROEUROPE-IP and GHG -EUROPE) and two national projects (CARBOITALY and National Inventory of Forests and Carbon forest pools). In particular one of the main objectives of these projects is to forecast on the medium-long run the dynamics affecting the climate-biosphere interactions with special regard to the forest ecosystems. Carbon and GHG cycles have been analysed in details in the past years at ecosystem and regional levels (also within a number of European projects, thus Ecomont, Carbomont, Carboeurope-IP, Nitroeurope-IP and the national FISR Carboitaly project). Yet many research questions are still open in the international scientific community, in particular regarding the carbon vulnerability, soil carbon dynamics and water balance. To understand the effects of climate change on the agro-forest ecosystems it is necessary to develop and parameterize very detailed physiological models of the main compartments (soil, vegetation and atmosphere) and of the mass and energy fluxes (solar radiation, carbon dioxide, water, nutrients). Models able to integrate physiological and ecological processes of the vegetation, such us the SVAT models that simulate the processes of carbon cycle (photosynthesis, respiration, C and N allocation, litter decomposition) and water cycle at daily to decadal time scales must be used. The application of these models to a longer time scale and to a larger spatial scale through spatialisation can be considered a difficult task. A very onerous data collection is needed in order to describe in detail the structure and functionality of the ecosystems during the vegetative period. To overcome this obstacle, some simplified physiological models have been proposed. A second strategy consists in using remote sensing assisted data, which are becoming more and more accessible, accurate and up-to-date. The availability of high frequency remote sensing data and eddy-covariance sites, where the functionality of the ecosystems is measured continuously, allows today to develop mixed models derived from remote sensing products and ancillary data collected in the field, which can bridge this gap. On this topic, the group is leader of the COST action ES0903, Spectral Sampling Tools for Vegetation Biophysical Parameters and Flux Measurements in Europe. The group is organized in three WPs related to soil (WP 1), vegetation (WP 2) and modelling (WP3) activities including SVAT models and the remote sensing approach.

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Project code: PJ10 AM 08

Effects of land use changes on soil carbon stock balance

RODEGHIERO MIRCO

Partner Institution: Faculty of Life Science, University of Copenaghen (DENMARK)

Scientific objectives

The main objective is the investigation of the effects of land use change on soil carbon stock with particular emphasis on natural colonization of grassland by forest trees. In fact, while in the conversion of agricultural arable land to forest there is an increase in soil carbon stock, it is not already clear what are the effects of the afforestation of natural non forested ecosystems on soil carbon stocks because contrasting results are emerging from literature review.

Statement of the research problem

The effects of land use change on soil carbon stocks are of concern in the context of international policy agendas on greenhouse gas emissions mitigation. In terrestrial ecosystems soils represents the major reservoir of organic carbon. Climate change can have a dramatic impact on soil carbon stocks because the temperature raising can accelerate the decomposition of soil organic matter with positive feedbacks on the greenhouse effect. Since small changes in soil organic carbon pools can have large impacts on the global carbon cycle, it's important to understand if soils are sinks or sources of carbon. The variations in soil carbon are small compared to the carbon stock and the major contribution to these variations are likely to come from land use changes. Therefore it's extremely important to quantify the effects of land use change on soil carbon dynamics.

Methods

In the Trentino Region the more common land use change is the natural colonization of grassland and pastures by woody tree species leading to the increase of forested area. The study will compare the soil carbon content with a paired sampling in forested areas and neighbouring non forested areas in order to detect differences in soil carbon and nitrogen content. The sampling will include soil bulk density determination besides soil stoniness, root content and surface obstacles. The sampling will include also the measurement of the main forest features (e.g. basal area, diameter at breast height,

wood volume and biomass). Moreover the interactive effects of environmental drivers, climate, land use history and forest management will be investigated.

Research group

Research activities of the forest ecology group are focused on the interactions between the vegetation canopy and the atmosphere chemical-physical layer and consider also the soil structure and functionality. In particular, energy and matter (carbon, water, nitrogen) fluxes between the atmosphere and the biosphere are analysed and models simulating vegetation systems and turbulent and radiative transfer are used. These data are up-scaled at a regional level to obtain a carbon balance integrating ground and remote sensing data bases. The interdisciplinary study on the interactions between vegetation, soil and climate is carried out also analysing the soil-canopy interaction. These activities are organized within two EU projects (DG Research, VI and VII framework, respectively NITROEUROPE-IP and GHG -EUROPE) and two national projects (CARBOITALY and National Inventory of Forests and Carbon forest pools). In particular one of the main objectives of these projects is to forecast on the medium-long run the dynamics affecting the climate-biosphere interactions with special regard to the forest ecosystems. Carbon and GHG cycles have been analysed in details in the past years at ecosystem and regional levels (also within a number of European projects, thus Ecomont, Carbomont, Carboeurope-IP, Nitroeurope-IP and the national FISR Carboitaly project). Yet many research questions are still open in the international scientific community, in particular regarding the carbon vulnerability, soil carbon dynamics and water balance. To understand the effects of climate change on the agro-forest ecosystems it is necessary to develop and parameterize very detailed physiological models of the main compartments (soil, vegetation and atmosphere) and of the mass and energy fluxes (solar radiation, carbon dioxide, water, nutrients). Models able to integrate physiological and ecological processes of the vegetation, such us the SVAT models that simulate the processes of carbon cycle (photosynthesis, respiration, C and N allocation, litter decomposition) and water cycle at daily to decadal time scales must be used. The application of these models to a longer time scale and to a larger spatial scale through spatialisation can be considered a difficult task. A very onerous data collection is needed in order to describe in detail the structure and functionality of the ecosystems during the vegetative period. To overcome this obstacle, some simplified physiological models have been proposed. A second strategy consists in using remote sensing assisted data, which are becoming more and more accessible, accurate and up-to-date. The availability of high frequency remote sensing data and eddy-covariance sites, where the functionality of the ecosystems is measured continuously, allows today to develop mixed models derived from remote sensing products and ancillary data collected in the field, which can bridge this gap. On this topic, the group is leader of the COST action ES0903, Spectral Sampling Tools for Vegetation Biophysical Parameters and Flux Measurements in Europe. The group is organized in three WPs related to soil (WP 1), vegetation (WP 2) and modelling (WP3) activities including SVAT models and the remote sensing approach.

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Project code: PJ10 AM 09

Modelling the physical and biological dynamics in large and deep lakes: application of coupled hydrodynamic-ecological models.

SALMASO NICO

Partner Institution: Helmholtz-Zentrum für Umweltforschung GmbH – UFZ (GERMANY)

Scientific objectives

Several recent studies documented the complex relationships between hydrodynamics and biological dynamics in lakes and reservoirs, underlining that algal community dynamics can only be understood taking into account the hydrodynamics of the system. This new level of understanding was favoured by the application of complex hydrodynamic models coupled with biological models. In this project, the relationship between physical and ecological processes in lakes will be analysed by applying process based coupled physical and ecological numerical models to the data recorded in a large and deep lake at the southern edge of the Alps (Lake Garda). More specifically, the objectives of the project are *i)* to explore how changes in nutrient loads from the watershed result in modifications of nutrient cycling and development of phytoplankton groups more linked to eutrophication, and *ii)* to evaluate the role of water thermal structure in favouring the seasonal growth of nuisance species and the development of cyanobacterial blooms.

Statement of the research problem

Lake Garda is the largest Italian lake. Its deepest station was recently included in the Long-Term Ecological Research Network (LTER; www.lteritalia.it). During the past 35 years, the lake experienced

an increase of phosphorus, and a tendency to an increase of water temperatures, in line with the warming recorded in other deep lakes at the southern and northern edge of the Alps. These changes were paralleled by significant modifications in the composition and structure of the phytoplankton community (Salmaso, 2010). The increase of nutrients was followed by an increase of nuisance species, which included metalimnetic cyanobacteria (*Planktothrix)* and bloom-forming species (*Anabaena*). An increase in cyanobacterial blooms was found also in the other subalpine large lakes. The causes determining the appearance of blooms require to be studied quantitatively in order to derive management strategies, and enable projections of future developments. The application of ecosystem models provides a promising tool for achieving these requirements. Besides the prediction of the occurrence of nuisance species, the fraction of toxic strains in the populations is another pressing problem that remained largely unsolved.

Methods

Simulation of hydrodynamic patterns will be carried out with a one-dimensional ecological lake model consisting of two coupled sub-models. The hydrodynamics model DYRESM (Dynamic Reservoir Simulation Model), which simulates stratification and mixing processes, is coupled dynamically with the ecological model CAEDYM (Computational Aquatic Ecosystem Dynamics Model) (Burger et al., 2007). Recent sophisticated implementations of the ecological model allowed extending simulations to carbon, nitrogen, phosphorus, and oxygen cycles, along with several phytoplankton, zooplankton and bacteria groups (Gal et al., 2009; Rinke et al., 2009). As for phytoplankton, in this work, from 3 to 5 phytoplankton functional groups will be simulated, including the 3 dominant taxa of Lake Garda (*Planktothrix*, *Mougeotia*, *Fragilaria*), as well as bloom-forming nuisance species (*Anabaena*).

Research group

The Limnology Group of the Research and Innovation Centre carries out studies on the ecology of lakes and rivers, long-term research on selected sites, and autoecological and molecular studies on keystone freshwater species. The research group includes a team of experts in limnological investigations, genetic and metabolomic, and statistical data processing.

Within this context, studies are being conducted on the trophic evolution of lake ecosystems in the Alpine region and at the southern border of the Alps. Specific research lines include:

- Changes in the physical, chemical and biological variables at different temporal scales, from months to decades and centuries (paleoecology).
- Update of the time series of hydrological, climatic and limnological data, with special attention to lake evolution and effects on biotic communities in relation to ongoing climatic changes; definition of predictive models.
- Environmental and biotic mechanisms favouring the development of cyanobacteria (including the recent appearance of blooms and new species in the deep southern subalpine lakes);

identification of the factors selecting for the development of toxic strains, the production and concentrations of epato- and neurotoxins, and their impact on trophic webs and water usability.

- Adaptive potential of natural populations of cyanobacteria in the lake district at the southern border of the Alps. The study is carried out on strains of the Planktothrix complex isolated from natural populations; the investigations are providing relevant information on the potential for this species to form algal blooms.
- Biogeographic distribution of planktonic species in the south-eastern Alps.

One of the more important investigations is being conducted on Lake Garda, which was included in the International Long Term Ecological Research network (ILTER) since 2007. Physical, chemical and biological data collected in this lake since the beginning of the 1990s represent one of the most complete long term limnological data series in Europe. The modelling of environmental and biological data will be carried out in the context of the most updated studies which are being conducted on lacustrine ecosystems in Europe.

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Project code: PJ10 AM 09

Remote Sensing and Systems for Environment Monitoring

GIANELLE DAMIANO

Partner Institution: Institute for Environment and Sustainability Joint Research Centre (ITALY)

Scientific objectives

Natural disasters are inevitable and it is almost impossible to fully recoup the damage caused by the disasters. But it is possible to minimise the potential risk by developing disaster early warning strategies, prepare and implement developmental plans to provide resilience to such disasters and to

help in rehabilitation and post disaster reduction. For the management of natural disasters a large amount of multi -temporal spatial data is required. Satellite remote sensing is the ideal tool for disaster management, since it offers information over large areas, and at short time intervals.
The main objective of this research is the development of methodologies for the analysis of remote sensing data, monitoring the consequences of environmental effects. More specifically this research proposal focuses on damage assessment of forestry ecosystems.

Statement of the research problem

Mitigation of natural disasters can be successful only when detailed knowledge is obtained about the expected frequency, character, and magnitude of hazardous events in an area. Many types of information that are needed in natural disaster management have an important spatial component. Spatial data are data with a geographic component, such as maps, aerial photography, satellite imagery, GPS data, rainfall data, borehole data etc. First of all, remote sensing and GIS provides a data base from which the evidence left behind by disasters that have occurred before can be interpreted, and combined with other information to arrive at hazard maps, indicating which areas are potentially dangerous. Then, when a disaster occurs, the speed of information collection from air and space borne platforms and the possibility of information dissemination with a matching swiftness make it possible to monitor the occurrence of the disaster. In the disaster rehabilitation phase GIS is used to organise the damage information and the post -disaster census information, and in the evaluation of sites for reconstruction.

Methods

Multispectral and hyperspectral data analysis has become a dynamic field of the environmental research in recent years. The complex, large amount of information obtained from the radiance or reflectance spectrum needs the development of new methods and techniques, in order to be able to utilize this data. It is a complex task, involving a deep analysis of the relations between many different parameters and the scale of analysis of damages strongly depends on the objectives of the assessment.

Research group

Research activities of the forest ecology group are focused on the interactions between the vegetation canopy and the atmosphere chemical-physical layer and consider also the soil structure and functionality. In particular, energy and matter (carbon, water, nitrogen) fluxes between the atmosphere and the biosphere are analysed and models simulating vegetation systems and turbulent and radiative transfer are used. These data are up-scaled at a regional level to obtain a carbon balance integrating ground and remote sensing data bases. The interdisciplinary study on the interactions between vegetation, soil and climate is carried out also analysing the soil-canopy interaction. These activities are

organized within two EU projects (DG Research, VI and VII framework, respectively NITROEUROPE-IP and GHG -EUROPE) and two national projects (CARBOITALY and National Inventory of Forests and Carbon forest pools). In particular one of the main objectives of these projects is to forecast on the medium-long run the dynamics affecting the climate-biosphere interactions with special regard to the forest ecosystems. Carbon and GHG cycles have been analysed in details in the past years at ecosystem and regional levels (also within a number of European projects, thus Ecomont, Carbomont, Carboeurope-IP, Nitroeurope-IP and the national FISR Carboitaly project). Yet many research questions are still open in the international scientific community, in particular regarding the carbon vulnerability, soil carbon dynamics and water balance. To understand the effects of climate change on the agro-forest ecosystems it is necessary to develop and parameterize very detailed physiological models of the main compartments (soil, vegetation and atmosphere) and of the mass and energy fluxes (solar radiation, carbon dioxide, water, nutrients). Models able to integrate physiological and ecological processes of the vegetation, such us the SVAT models that simulate the processes of carbon cycle (photosynthesis, respiration, C and N allocation, litter decomposition) and water cycle at daily to decadal time scales must be used. The application of these models to a longer time scale and to a larger spatial scale through spatialisation can be considered a difficult task. A very onerous data collection is needed in order to describe in detail the structure and functionality of the ecosystems during the vegetative period. To overcome this obstacle, some simplified physiological models have been proposed. A second strategy consists in using remote sensing assisted data, which are becoming more and more accessible, accurate and up-to-date. The availability of high frequency remote sensing data and eddy-covariance sites, where the functionality of the ecosystems is measured continuously, allows today to develop mixed models derived from remote sensing products and ancillary data collected in the field, which can bridge this gap. On this topic, the group is leader of the COST action ES0903, Spectral Sampling Tools for Vegetation Biophysical Parameters and Flux Measurements in Europe. The group is organized in three WPs related to soil (WP 1), vegetation (WP 2) and modelling (WP3) activities including SVAT models and the remote sensing approach.

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Project code: PJ10 AM 11

Conservation genomics of two threatened Alpine species: mountain hare (Lepus timidus) and rock ptarmigan (Lagopus muta)

VERNESI CRISTIANO

Partner Institution:

University of Parma, Department of Environmental Sciences (ITALY) and Wildlife Ecology and Management, University Freiburg (GERMANY)

Scientific objectives

The main aim is to understand which are the main biotic and abiotic drivers of the patterns of intra-population genetic diversity and inter-populations genetic differentiation in two species adapted to high altitude habitats, mountain hare and rock ptarmigan. Measuring these patterns on a genome scale will help in the estimation of the adaptive potential of these species inhabiting one of the areas most sensitive to the effects of global change.

Statement of the research problem

At their southernmost range of distribution, mountain hare and rock ptarmigan are restricted to the main mountain ranges, living in typically high altitude habitats, usually above the tree line (i.e. about 1800-2000 m asl). Both species are characterized by peculiar adaptation to this environment such as moulting in winter season. High altitude areas are considered amongst the most sensitive to land use and climate change, resulting in potentially threatening events such as habitat fragmentation, high anthropogenic pressure and inter-species competition. It is now well known that the final outcome of these events on species persistence and survival is mainly related on how much genetic variation is retained inside natural populations. It has recently been shown that a more comprehensive understanding of how populations are coping with global change can be obtained correlating patterns of genetic diversity within populations and genetic differentiation among populations with landscape features (altitude, land cover type, presence of natural and artificial barriers to dispersal, etc.).

Methods

Samples for DNA analyses will be obtained through different sources such as opportunistic retrieval (e.g. feathers and faeces) and hunted animals. Insofar, most conservation genetics studies are based on a specific set of markers like mitochondrial DNA loci and nuclear microsatellites. In this project we plan to adopt a sort of genome scan approach by means of next generation sequencing technologies. Typing significant portion of the entire genome (in the order of hundreds of kB) is resulting in a twofold significant advantage: i) inference of most relevant parameters (e.g. effective populations size, inbreeding coefficient, gene flow rate, divergence time between populations) is statistically more robust,

also thanks to the adoption of the newly developed Approximate Bayesian Computation tools; ii) a lower number of samples for each site is required. Correlation of landscape features with genomic data will be accomplished through the combined use of already existing software packages and the development of specific statistical tools, to be conducted in strict collaboration with the FEM spatial ecologists.

Research group

Neutral Genetic Variation group at FEM-CRI is working in the field of conservation genetics, mainly focussing on vertebrate natural populations. Our activity is oriented to understand the main biotic and abiotic drivers of the observed patterns of intra-population diversity and inter-population genetic differentiation. Through conservation genetics we aim at promoting sustainable and scientific-based management of biodiversity resources, with specific attention on mountain areas. Our studies are particularly oriented to the spatial and temporal dimension, thanks also to the possibility of analyzing DNA retrieved from ancient specimens. Actually the group is formed by a PI (Cristiano Vernesi), a research assistant, a technician, a post-doc and a PhD student. We've got our own lab for performing all procedures, from DNA/RNA extraction and purification to DNA sequencing and genotyping. A physically separated lab allows molecular analyses of ancient/museum specimens.

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Project code: PJ10 AM 11

SLOW WATER – Mezzocorona

MAIOLINI BRUNO

Partner Institution: Institute of Ecology, University of Innsbruck (AUSTRIA) and University of Trento, Department of Civil and Environmental Engineering (ITALY)

Scientific objectives

Rehabilitation of residual wetlands or artificial waterways, as agricultural ditches, by re-using residual water from hydropower production.

The aim is to reduce hydropeaking in rivers while enhancing ecosystem benefits (groundwater recharge, biodiversity, water supply for irrigation, nutrient control etc.).

Statement of the research problem:

Flow and temperature are the main drivers of the ecological health of rivers (Bunn & Arthington, 2002).These variables will be the most affected by climate change, but most European rivers are already fragmented and their hydrological and thermal regimes severely altered. Channel straightening and reduction has been particularly severe in lowland areas where the environmental conditions foster high biodiversity and ecological processes, but competing for space with agriculture. Several important ecological processes, as denitrification, organic matter cycling, microbial metabolism, have also been strongly reduced.. As a consequence, freshwater biodiversity is here strongly menaced and habitat restoration is viewed as the most effective remediation. Agricultural ditches are known to be valuable habitats and biodiversity refugia in lowland areas (Herzon & Helenius, 2008) but are more and more suffering from water scarcity.

The major use of water resources in the Alps and other mountain regions is for hydropower production and hydropeaking is one of the ecological impacts resulting from this use. The effects on the ecosystems are well known and can be extremely severe, when the sudden changes of discharge exceed several times the base-flow conditions and are associated to changes of water quality and thermal regimes (Bruno et al., 2009). So the effects predicted by climate change will sum to existing human impacts on flow and temperature regimes (de Jong et al., 2005). Thus it is necessary to move towards different approaches in regard to water management, developing all possible activities to (re)habilitate optimal eco-hydrological conditions in natural and artificial waterways.

Methods

The water from the Mezzocorona power-plant is discharged in the Noce river, causing severe hydropeaking also in the Adige, to which the Noce is a tributary. Part of this water will be diverted into the existing ditches network in piana Rotaliana. Changes in flow and temperature regime will be studied. The ecological status of both river and ditches will be evaluated through three years using standard and experimental sampling designs. The study will regard the benthic and the hyporheic habitats and related fauna. Isotopic analyses will be used to evaluate ecological processes affecting the Nitrogen and Carbon cycles and water residence time.

Research group

The ECOHYDRO working group is composed at date by five researchers in close collaboration with hydraulic engineers in the University of Trento. The main aim is to apply a multidisciplinary approach to the study of Alpine freshwater ecosystems and of the thresholds of their capacity to produce benefits and goods to the environment and to human society. Such approach couples hydrology, ecology and

mathematical modelling to assess which are the main drivers influencing ecological processes in freshwater ecosystems, and to forecast changes induced by human activities and by climate change.
The main research topics regard:
Slow water: The major use of water resources in the Alps and other mountain regions is for hydropower production. Hydropeaking is one of the ecological impacts resulting from this use, and it occurs at the end of the production process, downstream of power plants. The effects on the ecosystems are well known and can be extremely severe, when the sudden changes of discharge exceed several times the base-flow conditions and are associated in changes of water quality and thermal regimes.
Slow Water aims at re-using excess water from pulsating and fast flowing rivers to rehabilitate residual wetlands or existing artificial waterways such as connected ditch systems in agricultural areas, abandoned quarries etc. The output will be a collection of different experiences in order to build a database of possible water re-use approaches that may facilitate decision plans for the hydrological and ecological restoration of freshwater habitats in Europe.
Part of the research is funded by the Interreg Alpine Space ALPWATERSCARCE.
Population dynamics and life cycles of benthic taxa in different hydrological conditions: to study of life cycles and population dynamics of benthic invertebrates (Ephemeroptera, Plecoptera, Trichoptera and Diptera Smuliidae) in stream reaches affected by thermal and hydrological alterations.
Groundwater ecosystems
The lack of recent research on hyporheic fauna in several sections of the Adige watershed, requires to extend some diversity quantification in less-investigated areas. The effects of the main anthropic impacts on the hyporheic assemblages (i.e. hydropower production on the upper reaches, water abstraction for multiple uses, increase in nitrate loads through agricultural practices in the lower reaches, etc.) thus assessed, will be investigated with an eco-hydrological approach.
Invasive species in Alpine freshwater ecosystems: status of the main species, population dynamics and environmental thresholds for further invasions and trends due to climate change. Studies will focus on invasive crayfish, zebra mussels and Impatiens glandulifera present in Trentino, to understand and quantify the ecological and evolutionary processes associated with species invasions and to build evolutionary scenari

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FOOD AND NUTRITION AREA

Project code: PJ10 AL 01

Real time monitoring of volatile organic compounds release in relation with textural and acoustic characteristics in apples : (Apple-VOC)

BIASIOLI FRANCO

Partner Institution: Department of Food Science, University of Otago, (NEW ZEALAND) and Ionicon Analytik Ges.m.b.H - Innsbruck (AUSTRIA)

Scientific objectives

To determine the textural properties based on mechanical characteristics and acoustic sound and volatile compound release of apples of known genome both available in Italy and New Zealand during break down in vitro and vivo.

Develop new instrumental techniques using state of the art texture analysers equipped with microphone that can simultaneously determine mechanical properties and acoustic sound related to human crispness perception in apples.

To monitor and determine how cellular disruption and enzymatic generation of volatiles can be measured by PTR-TOF-MS both during mechanical stress in vitro and during consumption (in-vivo) and elucidate the flavour-texture interactions in real food matrix (the apple).

To determine relationships between all instrumental and human sensory assessments of textural and flavour attributes of apples using time intensity measures and to determine relationships with data from proposed research on apples from both Italy and New Zealand with pre-existing hedonic qualitative consumer data.

Statement of the research problem

Italy is rank the 6th place in the worldwide apple panorama, and more than the 70% of this Italian production is concentrated in the Trentino-Alto Adige region. Of the entire apple plantation Golden Delicious cover about the 70%, this cultivar is easy to grow, and is quite well appreciated by the consumer, even if it is generally recognised that it lacks favourable texture propriety, mainly crispness, specially after a period of cold storage. Because of that the demand of novel cultivar characterized by higher texture characteristic and in particular crispness is very high, both from the growers as well as the consumer. In comparison, New Zealand exports over 45 different varieties of apples with limited understanding on the quality of the variety. In total New Zealand apple exports equate to $395 million per year. From a genetic point of view the research of the constitution of novel varieties with the level of

quality is complicated by the lack in accurate methodology addressed to the analytical determination of these quality parameters. Developments and applications of these new methodologies will provide a comprehensive understanding of the identity of aroma active volatile compounds, mechanical texture and acoustic properties responsible for apple quality during consumption, whilst allowing for cross comparisons between apple varieties grown in Italy and New Zealand. Recently FEM acquired both a Texture analyser with microphones for simultaneous determination of mechanical and acoustical properties of apple, and a new PTR-TOF-MS apparatus for rapid high sensitivity monitoring of volatile compounds. The latter being the only available in Italy and one of the few in the world.

Methods

This proposed research will consist of the following main methodological approaches that will be integrated in their application:

- Development of an experimental set up based on PTR-TOF-MS and texture analyser, which can monitor simultaneously the evolution of the mechanical/acoustic profile and the volatile compound release both “in vitro” and “in vivo”.
- In vitro and in vivo measurements of flavour release, mechanical texture and acoustic signal from a suite of known apple cultivars as well as breeding population.
- Time intensity sensory analysis of few selected apple traits related to texture and flavour attributes using a trained descriptive panel of assessors.

Research group

The PhD program will see the collaboration of three institutions:

1) The Research Group “Sensory Quality and Consumer Choice” of IASMA Research and Innovation Centre that carries out research in food science and technology with focus on innovative and multidisciplinary survey methods for the definition of perceived quality of food. Its main objective is to provide cutting-edge products that comprise nutritional and nutraceutical properties with high sensory quality. The group has significant expertise in performing sensory studies (descriptive, discriminative and consumer), in the characterisations of agroindustrial products and processes by standard and advanced instrumental methods, and in the application of multivariate and data mining techniques. Recently the research group focused also on the link of sensory and instrumental phenotyping with genomic (ref. Dr. Franco Biasioli, franco.biasioli@iasma.it).

2) The “Sensory science research centre” of Otago University, established in 1996 with funds from the University of Otago that is located on the main campus of the University. Facilities include booths for analytical trained panels and consumer science evaluations, and laboratories for teaching and research. The Centre now also uses PTR-MS to measure in real-time volatile compounds that are important in aroma quality (ref. Dr. Samuel Heenan, sam.heenan@otago.ac.nz).

3) Ionicon Analytik Ges.m.b.H., founded in 1998 as a spin-off company of the University of Innsbruck in order to produce commercial highly sensitive trace gas analysis instruments based on PTR-MS. Today it has 18 employees and has sold nearly 200 instruments worldwide. Some of the very recent milestones were (i) the introduction of a high mass resolution TOF mass analyzer, (ii) the improvement of the detection limit down to the ppqv level and (iii) the ability to change the reagent ions (H3O+, O2+, NO+) which widens the range of measureable compounds and enables the separation of isomeric compounds. (ref. Prof. T.D: Maerk, tilmann.maerk@uibk.ac.at)

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Project code: PJ10 AL 02

Chemometrics and stable isotope ratios of bioelements

WEHRENS RON – CAMIN FEDERICA

Partner Institution: Institute for Molecules and Materials (IMM) - Analytical Chemistry, Radboud University Nijmegen (THE NETHERLANDS)

Scientific objectives

The project aims to ascertain to what extent stable isotope ratios in foods are related to the climatic and geographical characteristics of the provenance area and are affected by climate changes. Moreover it aims to develop suitable statistical multivariate procedures capable of creating isotopic traceability models for different foods. The project will open up new possibilities for traceability and fraud detection.

Statement of the research problem

Chemometrics is a chemical discipline that uses mathematical, statistical and other methods to provide maximum relevant chemical information by analyzing chemical data. It helps to better understand and interpret the analytical data, mainly when several analytical parameters and variables have to be taken into account.

The stable isotope ratios of H, C, O, N, S are related to the climatic (temperature, amount of precipitation, irradiance, humidity..) and geographical (distance from the sea, elevation, latitude, longitude) characteristics of the provenance area, but up to now the mathematical relations e.g for wine have not been deeply investigated and are not available in the literature. These relations will allow to

develop specification prediction models (isoscape) able to predict the natural isotopic composition of foods on the basis of the geographical coordinates and the climatic characteristics of the production region and to verify the declared origin of commercial products. Moreover the relations will allow to investigate if the climate change has had an impact on stable isotope ratios of foods.

Methods

Using visualisation methods such as principal component analysis and self-organising maps the project will start with an explorative analysis of the data. This should identify any outlying observations, and provide information on how to fit parsimonious models. These will be created under a rigorous validation regime in order to prevent overfitting of the data. The data will be analysed spatially using GIS and spatial statistics.

Research group

The **group of Biostatistics and Chemometrics** performs methodological research and provides support to FEM research groups in these areas. Key competences: multivariate statistics, optimization, exploratory data analysis, modelling.

The **stable isotope platform** is a competence centre for development and application of stable isotope ratio analysis (SIRA) of light bioelements (H, C, N, O, S) in different matrices. It is equipped with the most complete instruments to perform isotope analysis:1 x Site-specific Natural Isotope Fractionation Nuclear Magnetic Resonance (SNIF-NMR) and 4 x Isotope Ratio Mass Spectrometers (IRMS), interfaced with Elemental Analyser (EA), Pyrolyser (P), Gas Chromatographer/Combustion-pyrolysis (GC/C-P), CO2 equilibration system (CO2-EQ). Leader laboratory at national level for the application of SIRA in food authentication and traceability, the platform aims to develop competence in supporting studies in the field of ecology, physiology, hydrology and paleoclimatology. The group has been involved in several projects funded by European (recently the TRACE FP6 project), national, regional and private agencies.

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Project code: PJ10 AL 03

Innovative GC and HPLC IRMS methods

CAMIN FEDERICA

Partner Institution: FERA, The Food and Environment Research Agency (UK)

Scientific objectives

The project will develop innovative methods using IRMS (Isotope Ratio Mass Spectrometer) connected with GC and HPLC with 2 principal aims:

- determine the natural isotopic composition of food components in order to identify the addition of synthetic flavours or preservatives to foods
- investigate specific metabolic pathways or reaction mechanisms.

The results of the project will have both a scientific and a practical impact.

Statement of the research problem

The stable isotope ratios of bioelements (H, C, O, N, S) analysed mainly using Isotope ratio mass spectrometry has been largely used to detect food frauds, such as watering, sugar addition and to trace the origin of foods. The interface of IRMS with GC or HPLC allows the direct determination of the stable isotope ratios of specific components avoiding preliminary time consuming processes of separation. It can be used to detect the presence of synthetic ingredients in several foods (EU Reg 1334/2008) or the mixture of olive oils with other oils, due to the different isotopic composition of natural and synthetic compounds and of vegetable oils. Moreover, when using media or reactants enriched in the heavier isotope (e.g. ^{13}C, ^{15}N), it can permit improved understanding of specific metabolic pathways and reaction mechanisms.

Methods

GC- and HPLC- IRMS. The methods will be developed with the support of the GC and HPLC MS techniques.

Research group

The **stable isotope platform** is a competence centre for development and application of stable isotope ratio analysis (SIRA) of light bioelements (H, C, N, O, S) in different matrices. It is equipped with the most complete instruments to perform isotope analysis:1 x Site-specific Natural Isotope Fractionation Nuclear Magnetic Resonance (SNIF-NMR) and 4 x Isotope Ratio Mass Spectrometers (IRMS), interfaced with Elemental Analyser (EA), Pyrolyser (P), Gas Chromatographer/Combustion-pyrolysis

(GC/C-P), CO2 equilibration system (CO2-EQ). Leader laboratory at national level for the application of SIRA in food authentication and traceability, the platform aims to develop competence in supporting studies in the field of ecology, physiology, hydrology and paleoclimatology. The group has been involved in several projects funded by European (recently the TRACE FP6 project), national, regional and private agencies.

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AGRICULTURE AREA

Project code: PJ10 AG 01

Fine mapping, cloning and characterization of fire blight resistance genes from *Malus fusca*

MALNOY MIKAEL

Partner Institution: Julius Kühn-Institut (JKI) and Federal Research Institute for Cultivated Plants, Dresden (GERMANY)

Scientific objectives

The aim of this project is to clone and characterize a resistance gene from Malus fusca, to fire blight. Fire blight is a destructive and economically important disease of apple. Cloning and characterizing the genes involved in the mechanisme of resistance of this species of apple can help to understand the base of teh resistance and also in the future help to find new startegy to increase teh resistance of apple agianst this destructive disease.

Statement of the research problem

Fire blight has been a destructive and economically important disease of species of the subfamily Maloideae including apple and pear, for over 200 years. In recent years this disease caused serious economic losses around the world in apple (Malus x domestica Borkh.), which is one of the most cultivated fruits in the colder and temperate regions of the world. Extensive knowledge is available on disease symptoms, epidemiology, and behavior of apple host genotypes; and in particular on the pathogen, however, the biochemical and genetic basis leading to infection or resistance of apple host plant are still relatively unstudied. No resistance gene or mechanisme of defence against this pathognes has been describe. This project aime to understand the base of the resistance of Malus Fusca to this pathogene.

Methods

During this project several methods will be used, which include mapping of SNP or SSR marker, BAC screening, BAC sequencing, Gene cloning, Gene expression study, Genetic engineering.

Research group

Fire blight, caused by the bacterial pathogen *Erwinia amylovora*, is an extremely destructive disease in apple and pear. Traditional control methods, antibiotics or biological control agents were shown to have unsatisfactory results. A more environmental friendly and long lasting control method would be the

strategic deployment of natural resistance to this disease. Combinations of resistance to fire blight and high fruit quality, i.e. a fire blight resistant cultivar competitive in the market, are until now not attained. Therefore identification and introgression of resistances into commercial cultivars are necessary. One interesting donor is the wild species *Malus fusca*, highly resistant to the pathogen. The goal of this project will be to identify, isolate and characterize the source of resistance to fire blight from *Malus fusca*. The PhD student project will be to fine map the resistant gene in a population of 1000 individuals, clone the resistant and susceptible allele from an available BAC-library and to characterize the expression of these genes. According to the time frame the introgression of candidate genes in to another genetic background to check the functionality of potential candidate gene via genetic engineering should be considered.

This PhD project will be held in a cooperation of two research groups (one in Italy (FEM) and the other in Germany (JKI)) leading research on the molecular basis of disease resistance in apple, principally on the interaction between *Malus* and *Erwinia amylovora*. Both research groups are involved in projects on resistance gene mapping and cloning, and together they have additional expertise in transcriptomic analysis of gene differentially express during plant pathogen interaction and inoculation procedures. Both groups have successfully established transformation procedures for apple and accomplished the transformation of apple genotypes to increase resistance to fire blight. Both research groups collaborate with labs worldwide, e.g. for studies of disease resistance or a-biotic stress. Both research groups are composed of technician, PhD student and .researcher. One group has additionally a post Doc.

List of scientific references

Dr Andreas Peil which will be the co-cordinator of the project (JKI Institute, Dresden, Germany)
Pr Viola Hanke (JKI, Dresden Germany)
Dr Jay Norelli (USDA, USA)
Pr Herb Aldwinkle (Cornell University, USA)

Project code: PJ10 AG 02

Genetic investigation of seed development in grapevine

COSTANTINI LAURA

Partner Institution: Departmento de Genética Molecular de Plantas, Centro Nacional de Biotecnologıa, CSIC, Madrid (SPAIN)

Scientific objectives

This proposal is aimed at unravelling the genetic regulation of seed development in grapevine through the morphological and molecular characterization of a seedless somatic variant. The main objectives are the formulation of testable hypotheses on genetic functions that might be altered in the seedless phenotype and the identification of the allelic differences accounting for the phenotypic differences. These polymorphisms might ultimately be applied to marker-assisted selection (MAS) for the rapid and efficient screening of seedlings with the potential to produce seedless fruits.

Statement of the research problem

Seedless grapes are of interest for both fresh fruit consumption and raisin production. A major quantitative trait locus (QTL) affecting berry weight and seed content was identified in a stable chromosomic position through family mapping experiments carried out in distinct genetic backgrounds, years and environments. Based on its co-localization with this QTL, a candidate gene was suggested to play a role in trait variation, but functional testing was not performed yet. The availability of spontaneous somatic variants might further help to understand the genetic control of seed development, as already demonstrated for other traits. A seedless somatic variant was identified in a previous project.

Methods

In order to identify genes specifically associated with seedlessness, transcriptional profiling of the seedless and wild type (WT) phenotypes will be performed at early stages of inflorescence and berry development. For genetic analysis aimed at investigating the inheritance of the seedless phenotype as well as the segregation of candidate gene allelic variants, progeny populations involving the seedless individual will be produced. In order to circumvent the problem of grapevine long generation time, a rapid flowering picovine might be used as pollen acceptor, possibly in the state of a near-homozygous line. The most promising candidate genes (CG) will be cloned and sequenced in order to identify polymorphisms underlying trait variation. Chimeric cell layers might be separated to highlight CG sequence variants. Finally, in depth analysis of spatial and temporal expression patterns of some genes and alleles will be carried out in the WT and the mutant.

Research group

The hosting research group at FEM-IASMA, which is coordinated by dr. Maria Stella Grando, has a strong experience in the genetic dissection of target traits in viticulture and is especially focused on fruit development and composition (phenology, seed content and morphological characters, accumulation of aromatic compounds, anthocyanins, flavonols and amino acids in the berry). Candidate genes putatively involved in the control of trait variation are being identified through the combination of different approaches (QTL mapping in populations derived from crosses between divergent parents, transcriptomic and metabolic analyses). The functional role of the most relevant candidate genes is

being further assessed by means of expression analysis, genetic transformation and association mapping in core-collections of germplasm.
The group has been involved in several European initiatives, such as EraNet PG GRASP, GRAPEGEN06 and COST Actions. It currently comprises three researchers (Maria Stella Grando, Laura Costantini, Juri Battilana), one post-doc (Francesco Emanuelli) and two graduate technicians for lab and field work (Maddalena Sordo, Silvia Lorenzi).

The hosting laboratory in Spain, which is coordinated by dr. José Miguel Martínez-Zapater, is well-experienced in unravelling the molecular mechanisms underlying the reproductive development in plants. They have been focused on the genetic bases of flowering in the model species Arabidopsis, in relevant crop species from other botanical families with different lifestyles and more recently in grapevine as well. They have already dealt with the study of grapevine developmental somatic variants.

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