

PhD in AGRIFOOD AND ENVIRONMENTAL SCIENCES

CALL 2023 – CYCLE 39

Reserved scholarship:

A - An analysis of the contracts regulating the transfer of innovative genetic materials in the viticultural sector

Funding Body: **University of Trento and CIVIT (Consorzio Innovazione Vite)**

Supervisor 1: **Matteo Ferrari**

Supervisor 2: **Arturo Pironti**

Context / Synthetic description of the project and research outcome

The licensing, sale or otherwise transfer of new viticultural genetic materials is regulated through contracts that aim at establishing the rights and duties parties have in getting access and using such innovative materials. These contracts are characterized by peculiarities reflecting the legal tools employed for protecting the genetic materials to be transferred, ranging from plant variety certificates to patents, from non-disclosure agreements to trade secrets, as well as other types of regulatory schemes impacting on the contracts' structure and contents (e.g. phytosanitary certifications). The project will investigate the different types of contracts that are employed in the viticultural sector in close cooperation with the CIVIT, taking also into account the fact such contracts are increasingly transnational in character and involve parties operating in different legal systems. CIVIT represents the consortium grouping together plant breeders (in particular: Fondazione E. Mach) and plant nurseries (in particular: Vivaisti Viticoli Trentini) in Trentino; it has the scope of promoting innovation in the viticultural sector. It plays a vital role in translating research outcomes into products that can be marketed and it routinely signs contracts for the sale, licensing, transfer of innovation viticultural materials. The outcome will be represented by the creation and refinement of contractual models that can support plant breeders, nurseries and other professional operators involved in the transfer of viticultural genetic materials in their daily activities.

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Reserved scholarship:

B - Residual biomass conversion to value-added materials for electrochemical applications

Progetto INEST- SPOKE 3

Codice Progetto ECS00000043

CUP E63C22001030007

Funding Body: **University of Trento – Project: iNEST_Spoke3, Research Topic 1 Energy**

Supervisor 1: **Luca Fiori**

Supervisor 2: **Michele Orlandi**

Context / Synthetic description of the project and research outcome

The research project is framed within the general objective “Energy conversion equipment for biomass, industrial and urban waste energy recovery, and CO₂ in chemicals and in green energy (hydrogen, methane) for a circular economy”.

The specific aim of this PhD research project is the residual biomass conversion to value-added carbon materials for electrochemical applications.

The PhD research consists of five tasks:

- Current technologies for Hydrothermal Carbonization (HTC) processes and photoelectrochemical (PEC) CO₂ conversion.
- HTC testing of selected substrates, from model compounds to real waste biomass, also from the agro-industrial sector.
- Characterization of the solid products (hydrochar).
- Hydrochar investigation as support material for electrodes: upgrading and activation, electrochemical characterization.
- Coupling of the HTC and PEC technology for conversion of the CO₂ by HTC into solar fuels by PEC.

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Reserved scholarship:

C - Metabolomic and functional characterization of bioactive compounds of wild sage plants for downy mildew control in grapevine

Funding Body: **University of Trento AND Laimburg Research Centre**

Supervisor 1: **Michele Perazzoli**

Supervisor 2: **Peter Robatscher, Michael Oberhuber**

Context / Synthetic description of the project and research outcome

The European farm-to-fork strategy requires a significant reduction of chemical input in agriculture in the next years, but sustainable alternatives for plant protection are still limited. Frequent fungicide applications are required to limit downy mildew infections (caused by *Plasmopara viticola*) in grapevine with negative impacts on human health and the environment. Biological control agents, including natural products of botanical origin, are therefore highly desired as sustainable alternatives to chemical treatments. Preliminary results revealed the efficacy of alcoholic extracts of *Salvia* spp. in reducing downy mildew severity under controlled and field conditions. However, detailed information on the chemical composition of *Salvia yangii* (Russian sage) extracts is lacking, limiting the development of strategies to improve their efficacy.

This project aims to identify families of bioactive compounds in Russian sage extracts and to select growth conditions that maximize the accumulation of bioactive compounds, through tailored training of the PhD student in a multidisciplinary approach that includes cutting-edge metabolomic and physiological studies.

WP1. Identification of bioactive fractions of sage extracts (m1-m6). Alcoholic extracts of Russian sage will be fractionated with liquid chromatography and fractions will be tested for their inhibitory activity against downy mildew under controlled conditions to select bioactive Russian sage fractions.

WP2. Identification of bioactive compounds in bioactive Russian sage fractions (m7-m18). Russian sage crude extracts and bioactive fractions will be subjected to an untargeted metabolomics analysis with liquid chromatography coupled to mass spectrometry (LC-MS) followed by a molecular network analysis to annotate families of bioactive metabolites.

WP3. Validation and identification of the mechanism of action of selected bioactive compounds against grapevine downy mildew (m19-m30). Selected bioactive candidates will be purchased from chemical companies where available and they will be validated for their inhibitory activity against downy mildew under controlled conditions. The mechanisms of action of pure bioactive compounds against P.

viticola will be assessed with functional assays, such as microscopical, physiological, and gene expression analyses.

WP4. Selection of growth conditions that improve the accumulation of bioactive compounds (m19-m36). *Salvia yangii* plants will be grown under controlled conditions and exposed to water stress, heat stress, and light stress. The efficacy of crude extracts obtained from stressed and unstressed plants will be assessed against downy mildew under controlled conditions. In case of improved efficacy, the concentration of bioactive compounds will be assessed by targeted metabolomics with LC-MS analysis in alcoholic extracts of stressed and unstressed Russian sage plants.

WP5. Supervision and training (m1-m36). The PhD student will be co-supervised by weekly meetings and a high-level training program will be optimized to improve the competencies in plant physiology, metabolomics, and plant pathology.

WP6. Dissemination and outreach activities (m6-m36). Project results will be subjected to the decision to disseminate/publish or to protect/commercially exploit and intellectual property rights (IPR) will be jointly owned. Three publications in scientific journals and three presentations at international conferences are expected: i) identification of bioactive compounds in Russian sage extracts; ii) characterization of the mechanism of action of bioactive Russian sage compounds; iii) selection of growth conditions that maximize the accumulation of bioactive Russian sage compounds.

The outcome of this project will be a milestone in the development of biological products for grapevine protection against downy mildew based on metabolites identified in this study. The achievement of the expected results and dissemination activities will allow to successfully train and graduate the PhD student.

University of Trento, Italy (Centre Agriculture Food Environment, C3A)

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Reserved scholarship:

D - Climate change effects on the ecology and diapause metabolism of the European spruce bark beetle (*Ips typographus* L.)

Funding Body:

Unitn C3A + CNR-IBE (National Research Council of Italy; Institute of Bioeconomy)

Supervisor 1: **Mirco Rodeghiero** (Unitn-C3A)

Supervisor 2: **Livia Zapponi** (CNR-IBE)

Supervisor 3: **Andrea Battisti** (University of Padova)

Supervisor 4: **Martin Schebek** (Boku; Vienna)

Context / Synthetic description of the project and research outcome

Overview:

The bark beetle *Ips typographus* L. (Coleoptera, Curculionidae, Scolytinae) is the most destructive pest in Norway spruce (*Picea abies* (L.) H. Karst.)-dominated forests in Europe. Tree mortality caused by this insect has been quantified to exceed 150 million m³ from 1950 to 2000 (Hlásny *et al.*, 2021). Outbreaks are usually triggered by abiotic disturbance events (e.g., storms, snowfalls or drought) providing high amounts of breeding material which usually result in a rapid increase of beetle population densities, followed by severe Norway spruce mortality (Marini *et al.*, 2017). Due to the expected higher frequency of climate change-related weather extremes (IPCC,2013), the chance of bark beetle-caused disturbances is also expected to increase. Among the life-history-traits characterizing the propensity for outbreaks of this pest, the number of generations per year (*i.e.* voltinism) deserves particular attention because they can favour a rapid increase of the population density.

Project goals:

* Investigate the metabolism of *I. typographus* with respirometry and direct calorimetry measurements (Linghton, 2008).

* Comparing the metabolic rates of sympatric bark beetle species, to verify whether they contribute to the traits which predispose *I. typographus* to efficiently spread and establish.

* Understanding the key physiological features influencing the number of generations per year (Schebek *et al.*, 2022).

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Reserved scholarship: **E - Innovation in monitoring of mosquito vectors of human and zoonotic diseases in Italy**

Funding Body: **Centro Agricoltura Alimenti e Ambiente (C3A-University of Trento; PRIN 2020 ‘MosqIT’)**

Progetto PRIN 2020 TACKLING MOSQUITOES IN ITALY: FROM CITIZEN TO BENCH AND BACK/MosqIT", Protocollo:2020XYBN88, CUP: E43C22000360001

Supervisor 1: **Roberto Rosà (University of Trento)**

Supervisor 2: **Beniamino Caputo (University of Rome SAPIENZA)**

Context / Synthetic description of the project and research outcome

Mosquito-borne diseases (MBDs, e.g. malaria and arboviruses) represent a risk for 2/3 of the human population. Despite the public health burden is mostly in tropical regions, Italy is endemic for transmission of West Nile Virus by *Culex pipiens* and is stably colonised by the Asian Tiger mosquito, *Aedes albopictus*, which is a competent vector for several exotic arboviruses and has already been responsible for two chikungunya virus outbreaks in the country and autochthonous cases of Dengue virus. Additional invasive *Aedes* species (i.e. *Ae. japonicus* and *Ae. koreicus*) have more recently been established in Northern Italy, further expanding the risk of exotic arbovirus transmission. The “Piano Nazionale di prevenzione, sorveglianza e risposta alle Arbovirosi 2020-2025” (PNA) by the National Ministry of Health stresses the need for entomological surveillance and monitoring, of rising awareness in citizens and optimizing control interventions, to decrease the risk of arbovirus transmission and increase the preparedness of public health authorities and the civil society.

The PhD project aims to address the above need by introducing, validating and exploiting Citizen Science in the monitoring and surveillance of mosquito vectors in Italy, taking advantage of the already active Mosquito Alert ITALIA network (www.mosquitoalertitalia.it), coordinated by SAPIENZA University. In detail, the project will focus on: i) promotion and exploitation of the Mosquito Alert App among citizens and Municipalities; ii) cross-validation with data by conventional entomological collections; iii) building of open-source resources for real-time visualization of Mosquito Alert data; iv) data analysis and dissemination.

The expected major research outcome is to increase knowledge of the distribution, phenology and bionomics of mosquito vectors in Italy. The final goal is to improve the preparedness and capacity in Italy to deal with mosquito nuisance and reduce the risk of arbovirus transmission.

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Reserved scholarship:

F - Numerical modelling of atmospheric transport processes of particulate matter along mountain slopes

Funding Body: **University of Trento and Environmental Agency of the Autonomous Province of Trento**

Supervisor 1: **Dino Zardi**

Supervisor 2: **Gabriele Tonidandel**

Context / Synthetic description of the project and research outcome

Particulate matter, composed either of biogenic or abiogenic substances, play a crucial role in the environment, affecting air quality, atmospheric radiation budgets propagation of species, ecosystems' dynamics, human health, and nucleation processes in clouds, and hence precipitation.

Transport of such substances over mountainous terrain is made more complicated than over flat areas by the complexity and variety of the wind structures found over mountain slopes. In particular, thermally driven slope winds, often occurring after daytime heating and nighttime cooling of slopes, offer preferred flow patterns, which may variously combine with convection in the upper atmosphere. Also, turbulence associated with these flows plays a crucial role in the uptake, diffusion and deposition of these substances.

The candidate will develop and apply new concepts, derived from recent advances in our understanding of the above winds, to existing mathematical and numerical models, in order to improve their capability of reproducing the above transport processes in a variety of situations. Both Eulerian and Lagrangian approaches will be tested. The latter will include both forward- and back-trajectories.

Comparison with data from field measurements will allow suitable validation of the models.

Cooperation will be pursued with the Environmental Agency of the Autonomous Province of Trento, with the Botany Unit of the Civic Museum in Rovereto, and with the Environmental Botany Unit of the Edmund Mach Foundation.

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Reserved scholarship:

G - Development of molecular networking approaches for the analysis of untargeted metabolomics datasets (MoINet)

Funding Body: **Edmund Mach Foundation (FEM) and Laimburg Research Centre**

Supervisor 1: **Pietro Franceschi (FEM)**

Supervisor 2: **Mar Garcia Aloy (FEM)**

Supervisor 3: **Michael Oberhuber (Laimburg Research Centre)**

Context / Synthetic description of the project and research outcome

To secure food production new tools are required that control an array of insects, weeds, and plant diseases. Synthetic organic compounds have provided viable solutions over the past decades, but emerging resistance and increasing societal concerns with the environmental and health risks of pesticides create a critical need to develop new pest control tools. Evolution has given rise to more than 400,000 natural products, including metabolites from microbial, plant and animal origin, some of which play important roles in plants' defense against pathogens and have already been used as pesticides.

In recent years, metabolomics has re-powered the discovery of natural products: bioguided isolation approaches, assisted by metabolomics and computations tools, have an unprecedented potential for the selection of natural products with desired bioactivities. Among the community, however, it is widely recognized that de novo compound identification is one of the major bottlenecks in untargeted metabolomics.

The aim of the project is to implement and develop the “Bioactive molecular networking” (BMN) approach where the results of large scale biological assays are coupled with high resolution mass spectrometry (HRMS) and Nuclear Magnetic resonance (NMR) spectroscopy similarity networks to increase the ability of finding candidate phytotoxins from fractionated bioactive extracts of *Alternaria*. This genus encompasses a plethora of saprophytic or pathogenic fungal species, producing more than 260 bioactive metabolites. Some are mycotoxins and thus may pose a health risk to humans and animals through the consumption of contaminated food or forage; others are phytotoxins, with potential applications as herbicides. The PhD student will carry out her/his research both at Edmund Mach Foundation and Laimburg Research Centre.

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Reserved scholarship:

H - Biotremology for Pest Management: new solutions against stinkbugs and true bugs

Funding Body: **Edmund Mach Foundation (FEM), CBC Europe and CBC Iberia**

Supervisor 1: **Valerio Mazzoni**

Supervisor 2: **Gianfranco Anfora**

Context / Synthetic description of the project and research outcome

The communication of some insects can be multimodal or multichannel, that is, it is based on different signal types, such as chemicals and mechanicals. This type of communication allows for better adaptation to the environment and resilience to changes and is characteristic of many Hemiptera including stinkbugs (Pentatomidae) and mirids (Miridae). Through joint research in the field of biotremology and chemical ecology, the Shindo Trap has been available on the market since 2022. This is the first bimodal trap (pheromones + vibrations) for catching the Brown Marmorated Stinkbug, *Halyomorpha halys*. The next step will be to develop a similar approach towards other insects of agricultural interest. Targets of the research will therefore be the Southern Green Stinkbug, *Nezara viridula*, and the true bug, *Nesidiocoris tenuis*, of which vibrational and chemical communication are in part known. The project aims at investigating the function of vibrational signals in these species and identifying volatile compounds with which to manipulate their behavior. The final goal is to create the basis for innovative approaches and tools for crop protection.

Main objectives:

- 1) *Nezara viridula*: Selection of volatile compounds capable of guaranteeing the greatest effectiveness of attraction at a long-range distance. Selection and enhancement of the most effective vibrational signals in attracting the green stinkbug near the trap (short-range). Semi-field and field trials with Shindo traps modified with *N. viridula* species-specific signals. Evaluation of the possible integration of signals (simultaneous or alternating) for a trap effective against both *H. halys* and *N. viridula*.
- 2) *Nesidiocoris tenuis*: Selection of the most effective vibrational signals in manipulating the behavior of *N. tenuis*. Selection of volatile compounds able to influence the behavior of *N. tenuis*. Development of a prototype for the application of selected vibrational and chemical signals in a protected environment and efficacy tests in a greenhouse.