Plenary Session 1 - Keynote Speaker: Nick Mills

Nick Mills completed a BSc in Biological Sciences in 1975 and a PhD on the population ecology of a coccinellid predator of aphid in 1979, both from the University of East Anglia in the UK. After a four-year period as a Cook Junior Research Fellow at Lincoln College, Oxford University he joined CABI in 1982. Following an initial appointment as Head of Forest Entomology at the Swiss Centre, he became Director of the UK Centre in 1988. Soon after he accepted a professorship in entomology/ biological control at the University of California, Berkeley in 1990. He has served both as Chair of the Department of Environmental Science, Policy and Management and as Executive Associate Dean for Research and Extension in the Rausser College of Natural Resources at UC Berkeley, and is currently an Emeritus Professor of Entomology. His research interests bridge the gap between theory and practice in biological control with a focus on the ecology of arthropod predators and parasitoids, the dynamics of biological control systems, and the linkage between importation biological control and invasion biology. He has served in an editorial capacity for six different scientific journals and contributed to both national and international science review panels. During his career at UC Berkeley he received awards for undergraduate teaching and graduate mentorship, as well as for research excellence.

Biological Control for One Health

Urs Schaffner[2], George Heimpel[3], Nicholas Mills[1], Beatrice Muriithi[4], Matthew Thomas[5], Yubak GC[6], Kris Wyckhuys[7]

[1]University of California, Berkeley, US, nmills@berkeley.edu; [2]CABI, Delemont, CH; [3]University of Minnesota, St. Paul, US; [4]ICIPE, Nairobi, KE; [5]University of Florida, Gainesville, US; [6]FAO, Bangkok, TH; [7]Chrysalis Consulting, Danang, VN

Biological control is a biodiversity-driven ecosystem service that has been effectively exploited by mankind since 300 CE. By promoting the natural regulation of pests, weeds, and diseases, it produces societal benefits at the food-environment-health nexus. The concept of 'One Health' provides a uniquely useful paradigm for gauging the broader implications of environmental change while accounting for the interconnections between people, animals, plants, and their shared environment. Disciplinary silos and reductionist approaches hamper our understanding and eventual mitigation of complex issues while the One Health framework underlines how close cooperation between professionals in the human, animal, plant, and environmental health sciences can spawn unprecedented societal benefits. Evidence shows that biological control generates desirable outcomes across all One Health dimensions, mitigating global change issues such as chemical pollution, biocide resistance, biodiversity loss, and habitat destruction. Yet, its cross-disciplinary achievements remain unrecognized. Here we argue that a broader use of biological control can help address multiple One Health challenges with examples of how biological control contributes to each of the four interrelated One Health dimensions, i.e., environmental, plant, animal and human health. We emphasize that in addition to its direct benefits, such as reduced densities of crop pests or vectors of human diseases, there are underappreciated indirect benefits, including reduced environmental pollution, enhanced habitat conservation, and increased human and livestock health. We advocate a system-level, integrated approach to biological control research, policy, and practice. Framing biological control in a One Health context helps to unite medical and veterinary personnel, ecologists, conservationists and agricultural professionals in a joint quest for solutions to some of the most pressing issues in planetary health.

Plenary Session 1 - Keynote Speaker: Raghu Sathyamurthy

Raghu Sathyamurthy completed his bachelor's degree in Zoology (Madras, India; 1996) and his masters in Environmental Management (Griffith, Australia; 1998), and a PhD in Ecology & Entomology (Griffith, Australia; 2002). His graduate research focused on the ecology and evolution of plant-insect insect interactions where he focused on these dynamics from the insect's perspective. Since 2002 he has been working on the biological control of weeds, with a focus on plant-herbivore interactions principally from the plant's perspective. An empirical and quantitative ecologist, his research interests span invasion dynamics, plant-herbivore interactions, integrated population management, and biological control of invasive species. He endeavours to undertake all his research collaboratively, and in close partnership with end-users of science to ensure the research outputs have the best possible chance to be translated into practical outcomes and, eventually, longer-term impacts. He has served as Associate Editor for Environmental Entomology, Biological Control and BioControl. Raghu currently leads a national research program in Biosecurity within Australia's National Science Agency, CSIRO.

A nod to the past and present, with an eye to the future: advances needed to sustain the next chapter(s) of biological control

Raghu Sathyamurthy[1]

[1]CSIRO, Brisbane, AU, S.Raghu@csiro.au

The intersecting impacts of climate change, increased trade and travel, changing land use patterns, and significant international efforts to reduce the use of chemicals in agricultural and environmental interventions, necessitate sophisticated approaches to mitigating biosecurity risks. Biological control has been a valuable asset in the management of such risks (invasive pests (vertebrate and invertebrate), weeds and diseases) for over a century. While this historical legacy is assured (even if sometimes questioned), sustaining the discipline over the next century will require ongoing efforts to modernise all aspects of the discipline. In this talk, I will highlight some emerging trends and approaches spanning the spectrum of activities in biological control (i.e. target selection, agent selection, risk assessment, post release evaluation, integrated management, regulatory engagement, international conventions governing access and benefit sharing). Some of this will challenge the *modus operandi* in the discipline, but meeting this challenge will be essential to strengthen and advance the future of the discipline and share its benefits globally.

Plenary Session 3 - Keynote Speaker: Tara Gariepy

Tara Gariepy completed a BSc at Concordia University, specializing in parasitology and entomology. This was followed by a Masters degree in Pest Management at Simon Fraser University, focusing on epidemiology and molecular diagnostics of plant pathogens. In 2002, she did an internship at CABI-Europe Switzerland on biocontrol of invasive insect pests, which led to her PhD research (2003 – 2007) on the use of molecular tools for non-target risk assessment in biological control (a collaboration between CABI, Agriculture and Agri-Food Canada, and University of Saskatchewan). From 2007 to 2009, she held a NSERC post-doctoral fellowship at University of Hawaii at Manoa, Kauai Agricultural Research Centre, where she conducted research on the use of molecular tools to assess competitive interactions between biocontrol agents of invasive aphids. This was followed by an Ontario Ministry of Research and Innovation post-doctoral award at the University of Guelph and Canadian Centre for DNA Barcoding, on DNA barcoding of parasites and insect vectors of disease. In 2011, she joined Agriculture and Agri-Food Canada as a Research Scientist at the London Research and Development Centre in Ontario. Her research focuses on importation biological control of invasive insects, and development of molecular tools to detect and evaluate trophic interactions between insect pests and their natural enemies.

The use of molecular tools to unravel host-parasitoid associations in biological control of invasive insect pests

Tara Gariepy[1]

[1]Agriculture and Agri-Food Canada, London, CA, tara.gariepy@agr.gc.ca

Trophic interactions between hosts and their parasitoids can be difficult to detect and identify using conventional methods, particularly when several closely-related and morphologically similar parasitoids co-exist in the same habitat or on the same host species. Molecular tools can help identify these interactions, which improves our understanding of food web ecology and provides valuable information to guide biological control decisions. Several examples will be presented on how these tools are applied at different stages in the discovery and use of parasitoids in biological control programmes for invasive insect pests.Plenary Session 1 - Keynote Speaker: Raghu Sathyamurthy

Plenary Session 3 - Keynote Speaker: Ted Turlings

Ted Turlings did his studies at Leiden University, where he obtained a bachelors and masters degree in Biology, with a specialization in Ecology. In 1985 he moved to the University of Florida to conduct a PhD in Entomology/Chemical Ecology. During his PhD he discovered that insect-damaged plants emit specific volatile signals that attract parasitic wasps. The discovery of herbivore-induced volatiles has led to numerous follow-up studies by dozens of research groups, which resulted in thousands of publications on the topic. After a brief post-doctoral period in Florida he moved to Switzerland in 1993. He first spent three years at the ETH-Zurich and in 1996 he obtained a prestigious START-fellowship, which he took the University of Neuchâtel to start his own research group. Eventually he was nominated full professor at the same university where he helped to establish the National Centre of Competence in Research *Plant Survival*, a swiss-wide research network that he directed for four years. Currently, he is head of the laboratory of Fundamental and Applied Research in Chemical Ecology (*FARCE*), which focuses on the use of plant-produced signals to improve crop protection. He has received several awards related to the field of chemical ecology and entomology. In 2023 he was elected president of the International Society of Chemical Ecology and was given the Marcel Benoist Prize, Switzerland’s most prestigious science award.

Herbivore-induced plant volatiles and how they can be exploited for targeted biocontrol

Ted Turlings[1]

[1]*University of Neuchâtel, Neuchâtel, CH, ted.turlings@unine.ch*

Natural enemies of herbivorous pests often use plant-provided signals to locate plants that carry potential prey. Particularly intriguing are so-called herbivore-induced plant volatiles (HIPVs), which various plants release in large quantities only when they are attacked by insects (Turlings and Erb, 2018). Aboveground, HIPVs serve as foraging cues for predators and parasitoids, whereas belowground they are exploited by entomopathogenic nematodes. I will present results on our efforts to utilize these plant-produced signals to enhance the efficacy of biological agents. Belowground we have succeeded at making rootworm-damaged maize roots more attractive to entomopathogenic nematodes. Another focus is the use of odor sensors that can be placed on robotic rovers to detect HIPVs in real-time, allowing farmers to determine the presence of specific pests on crops before they do serious harm. The same rovers could then apply biocontrol agents to control these pests, but only when and where it is really necessary.

Turlings, T.C.J. and M. Erb (2018). Tritrophic interactions mediated by herbivore-induced plant volatiles: mechanisms, ecological relevance, and application potential. *Annual Review of Entomology* 63: 433-452

Plenary Session 4 - Keynote Speaker: Tania Zaviezo

Tania Zaviezo did her undergraduate studies at Universidad Catolica de Chile, where she obtained a bachelor's degree in Agricultural Sciences. In 1992 she moved to the University of California at Berkeley (USA) to conduct a PhD in Entomology/Biological Control. During her PhD she studied the evolution of clutch size in gregarious parasitoids and also looked at the interspecific relationships among parasitoids with different life-history traits. From then on, most of her research has explored the question of how biodiversity at different levels, from population genetics to landscapes, influences the outcome of biological control. Upon finishing her Ph.D she returned to Chile, to be an assistant professor at School of Agriculture and Natural Systems, Universidad Catolica de Chile, and in 2011 was nominated full professor at the same university. Here, she leads the laboratory of Fruit Crops Pest Management, which focuses on alternatives to pesticides, such as importation and conservation biological control and the use of pheromones. During her career she has secured funding from competitive national and international agencies, and has collaborated with researchers in many parts of the world. She has also served in many academic positions, such as head of department and vice-dean of undergraduate education, among others. Currently she serves as the secretary for the International Branch of the Entomological Society of America.

Mind the gap: mechanisms in conservation biological control

Tania Zaviezo[1]

[1] *Departamento de Fruticultura y Enología, Facultad de Agronomía y Sistemas Naturales, Pontificia Universidad Católica de Chile, Santiago, Chile*

Conservation biological control is an approach that encompasses a diverse set of practices that aim to preserve natural enemies and enhance their activity in order to improve their impact on the pest. It is probably the oldest form of biological control, but relatively new as an area of research. Conservation biological control practices aim to provide complementary or alternative trophic and non-trophic resources, that can be achieved through non-crop habitat/vegetation manipulation; within crop management practices; or direct provision of the resources. Additionally, careful pesticides use in conventional agriculture can be important for conserving natural enemies. Habitat or vegetation manipulation is probably the most studied and used tactic within conservation biological control, ranging in temporal and in spatial scale. Nevertheless, many gaps in knowledge must be addressed before habitat manipulation becomes an effective and more consistent practice, because mechanisms explaining the patterns and effects observed are rarely evaluated. In this talk we will present studies that provide evidence of the mechanisms by which conservation biological control practices increases natural enemies and/or biological control in crops. We will also highlight in which areas of conservation biological control there are the more studies on mechanisms and in which there are more gaps. Finally, we will give some suggestions on how to improve studies in order to move forward in making this strategy more transferable among cropping systems and locations.

Plenary Session 4 - Keynote Speaker: Ralf-Udo Ehlers

Ralf-Udo Ehlers finished his studies in Agriculture in 1985, received his PhD in 1989 and habilitation in 2003. His research focused on the development of liquid culture technology of entomopathogenic nematodes (EPN) at the Institute for Phytopathology of the University Kiel (Uni Kiel), Germany. In 1996, he founded the biotechnology company e-nema, which today is the largest producer of nematodes for biological control of insect pests. From 1988 until 2011, he was first subgroup convenor and then convenor of the IOBC/WPRS Working Group „ Insect pathogens and entomoparasitic nematodes“. From 1992 until 2010, he was participating and serving as vice chairman and chairman of several EU COST Actions on EPN and Bacillus thuringiensis. Apart from his R&D in EPN he also worked on the use of microbial agents in biocontrol of insects and plant diseases. In 2006/2007, he coordinated the EU Specific Support to Policy Action REBECA: Regulation of biological control agents in Europe. Since 2004 he is guest professor at the University Gent, Belgium and became professor at Uni Kiel in 2009. In 2012, he left Uni Kiel to concentrate on the management of e-nema GmbH. From 2013 until 2018 he served as executive board member and treasurer of the International Biocontrol Manufacturers Association (IBMA) in Brussels lobbying for biological control. From 2014 until 2022, he was president of the European Society of Nematologists. He received the Escherich Award of the German Society for General and Applied Entomology in 2015 and the IBMA Bernard Blum Award for the best biocontrol product of the year 2020 (dianem® for control of the invasive corn pest Western Corn Rootworm). He is honorary member of IBMA. In 2023, he withdrew as shareholder from e-nema and is since working as consultant in biocontrol biotechnology.

Role of biocontrol for transformation of agricultural practice

Ralf-Udo Ehlers[1]

[1]*Biocontrol Biotech Consult, Rastorf, DE, ruehlers@gmail.com*

The world is losing its diversity. In the last 25 years insect biomass has seriously declined. Main driver for insect decline is intensive agriculture (46.6%) followed by invasive species (16.4%), urbanization (10.7%) and deforestation (8.8%). Current agriculture practice heavily depends on synthetic pesticides but at the same time the tool-box of farmers is depleting, particularly with insecticides. Pests develop resistance, older actives are not re-registered, many active ingredients are banned, development of new actives is only possible at high costs and return of investment is declining why innovation is limited and new actives often have a narrow target spectrum. In the near future, agriculture will have to rely on biocontrol biodiversity. This transformation is hampered by a serious lack of knowledge. We know the antagonists but techniques how to promote their potential at farm level is less developed. R&D is needed to develop agro-ecosystem management strategies to enhance the potential of existing antagonists and to introduce and establish those agents, which are missing in the different habitats. Biocontrol industry can support the transition, however, the political environment prohibits the full exploitation of its potentials. Major hurdles are exaggerating data requirements for registration and xenophobic legislation when introduction of non-indigenous species/strains provide more benefits than risks. Externalisation of costs related to the use of synthetic actives would justify the support of biocontrol practice, however, such programmes are rare. Biocontrol industry made significant progress during the last two decades, contributing to a reduction of pesticide residues, substituting synthetic chemicals or filling gaps. How and in which sectors biocontrol industry can support transformation of agricultural practice with less or no insecticides will be demonstrated and discussed. The contribution of novel technologies will be reviewed.