Pest Control in Apple Orchards Under Future Climate Prediction, European Congress of Entomology, Naples, Italy, 1st-11th July 2018

Date of Travel: July 1st – July 11th

Name of GCRI Travel Grant Recipient: Stuart Edwards, PhD Student, University of Reading

Headline bullet points:

- Pest control under projected future climate change will be influenced by multi-trophic biological interactions
- Volatile Organic Compounds to become a pest control tool of the future?
- Provision of additional food resources may help natural enemies reduce pest populations

Background: The trip was comprised of two parts;

1) The XI European Congress on Entomology, Naples. A conference which featured a total of 460 talks and 560 posters covering a diverse range of topics from Agricultural and Forest Entomology to Morphology and systematics. Pest control became a recurrent theme throughout the conference with many sessions on Biological Control and Integrated Pest Management as well as Insects and Global Food Production.

2) Visit to the University of Naples Federico II. This visit allowed me to shadow the research group of Professor Francesco Pennacchio, a group specialising in crop pest research and parasitoid physiology. Throughout my stay I learned new research techniques and gained insights into future crop pests through a visit to the Institute for Sustainable Plant Protection.

Travel Findings:

There is a growing consensus that improving the sustainability of future food production will require an integrated approach that profits from beneficial species interactions such as natural pest regulation. This statement holds true as further public pressure and legislative restrictions reduce the range of insecticides available. Climate change and increased frequencies of extreme weather events pose threats to species interactions and concern is being raised as to the effects of these on pests and pest regulation. With the support of funding from the GCRI Trust and SCI David Miller Award I was able to attend the European Congress of Entomology, the following section outlines the major topics presented at the conference in relation to my project and their potential influences on the future of agricultural and horticultural pest control.

Biological control agents such as parasitoids are of the upmost importance to pest control. Therefore, species should be selected with suitable behavioural traits for the task at hand. Climatic change has the ability to adversely affect such behavioural traits and could reduce efficacy of certain species in controlling pest populations. Dr. Eric Wajnberg was one of the first speakers at the congress and he was quick to mention

that natural enemies can evolve to maximise their own fitness and not the economic viability of our food production. Often the evolutionary drives of behavioural plasticity in responses to environmental stressors operate in opposition to our needs as horticultural and agricultural practitioners. As such, careful consideration should be given when selecting a biological control agent. Professor Richard Stouthammer reiterated this point in his talk stressing that the right level of genetic variation in biological control populations is key. Too little genetic variation, as often seen in laboratory cultures, may lead to inbreeding depression or a failure to adapt to slight environmental changes, whereas too high a genetic variation could lead to the release of ineffective biological control in the field. Practitioners must consider that while a strain of biological control may be effective in the lab, such behaviour traits may not translate to successful control in field conditions. Dr Wajnberg highlights the important biological traits in terms of biological control are 1) residence time on host patches 2) clutch sizes 3) sex ratios 4) host marking strategies and 5) host choice. These behavioural parameters have been studied for several species of parasitoid but research is needed to develop understanding about how temperature and climatic variation will disturb these parameters from the norm.

Dr. Ainara Penalver-Cruz presented research on the influence of sugar sources on parasitism of Woolly Apple Aphids (*Eriosoma lanigerum*) by the specialist parasitoid *Aphelinus mali*. Woolly Apple Aphids are key pests in apple orchards worldwide. Dr.Penalver-Cruz presented research showing that distance from the apple orchards to nectar sources correlated with the efficacy of biological control of Woolly Apple Aphid. Apple orchards in close proximity to additional nectar supplies (such as *Pyracantha coccinea)* had increased parasitoid presence later in the season, along with an increased ratio of female parasitoids to males (females being the sex that controls aphid populations through parasitism). This highlights an important parameter in the behavioural ecology of *A. mali* and how habitat complexity may provide a role in supporting natural enemy populations. This information can be utilised by providing additional nectar sources and increasing biodiversity both surrounding and within orchards.

As well as top-down impacts on economically important trophic systems, biological control can also be influenced from the crop level (bottom-up). Research at the Angeli Lab of the University of Bozen-Bolzano worked to characterise 28 volatile organic compounds released by apples trees in response to herbivory by Green Apple Aphid (*Aphis pomi*) and the Rosy Apple Aphid (*Dysaphis plantaginea*). Volatile organic compounds (VOCs) are released as a form of plant communication in response to herbivory, this is important in pest control as VOC's act as a signal to natural enemies that prey is present close by. This research can potentially lead to novel methods of pest control under future pesticide use constraints. By identifying the VOC's produced by apple trees in response to herbivory there is potential to see which compounds are utilised by natural enemies in finding prey/pest species. Thus, in future organically managed horticultural systems, the use of VOC's could be seen as a method of attracting natural enemies and with it increasing the efficiency of pest control.

Professor Marcel Dyke of the University of Wageningen introduced a popular theme of the conference which was that of insect endosymbionts and their interactions and influence on the wider ecosystem. Endosymbionts of insect pests are direct drivers of pest fitness parameters. For example, aphids are often dependent on obligate

symbionts of the genus *Buchnera.* These are essential for the bioaccessibility of the nutrients contained within phloem. Endosymbionts may make pests more difficult to control. The endosymbiont *Hamiltonella defensa* is known as an efficient defence against parasitoids in many species of aphids and whitefly's, and endosymbionts also have the ability to influence the VOC's emitted by plants in response to herbivory. This poses challenges for pest control as, without a thorough understanding, future pest control methods could indirectly influence selection of microbes and endosymbionts beneficial to the pest increasing their fitness in a changing environment.

To conclude, the control of agricultural and horticultural pests is a primary entomological research focus worldwide, this was illustrated by the amount of talks focusing on such topics at the congress. Additionally, it is recognised that climate change will greatly affect pest control of the future. Current research however is highlighting that understanding the efficiency of biological control in the future is an extremely complicated matter with both top-down and bottom-up effects on trophic interactions. Whilst the surface of research is still being scratched in terms of biological control, keys areas are already emerging, such as the use of microbes and endosymbionts to influence pest behaviours, and the use of volatile organic compounds as a method for increasing the capacity for biological control to identify pest populations. Overall, this research trip has given me much to consider in terms of the effects of climate change on tritrophic interactions in apple orchards and as such I hope this reflects in the future quality and applicability of my research to the horticultural and agricultural industry.

Personal Statement:

Through attending the conference, conversing with fellow academics and shadowing the work of Professor Pennacchio's lab I have become aware of the novel research being conducted in the world of entomology. I have taken and developed ideas which have had an instant impact on my research, for example learning of new culture methods for my target species which will allow me to culture them through the winter months, as well as ideas which I can utilise in the future. My trip has also developed my academic way of thinking, allowing me to consider problems and approach questions in a different light.

Contact details:

Email: s.m.k.edwards@pgr.reading.ac.uk

Tel: 01183784397

Twitter: @SE_Entomology

Acknowledgements:

I wish to thank the GCRI Trust and the Society of Chemical Industry of which made this trip possible. Their funding provided me with an unforgettable learning experience of which I hope to do justice.

Secondly, I would like to thank Professor Pennacchio and his colleagues for welcoming me into their lab and accommodating me during my stay.