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Preface to the special issue: Recent trends in insecticide mode of action and resistance

Modern crop protection is still largely depending on the judicious application of agrochemicals to control invertebrate pests such as insects, mites and nematodes, and weeds and diseases. This Special Issue was mainly inspired by papers presented at the 14th International IUPAC (International Union of Pure and Applied Chemistry) Congress of Crop Protection Chemistry held from May 19–24, 2019 in Ghent (Dayan et al., 2019). The overall theme of one of the larger sessions, spanning several days and with more than 40 presentations, was "Mode of Action and Resistance". For this Special Issue we collected 12 papers primarily covering recent trends in invertebrate pest control with special reference to insecticide mode of action and resistance. The papers are authored by renowned experts in the field of invertebrate toxicology and resistance from both academia and crop protection industry.

It is well accepted that the availability of diverse chemical classes with different modes of action (MoA) is of utmost importance to design sustainable insect resistance management (IRM) strategies. New legislation has continued to put pressure on the pesticide portfolio – particularly insecticides – in some regions of the world, making the development, registration and commercialization of new modes of action more crucial today. The Insecticide Resistance Action Committee (IRAC) is continuously updating its insecticide MoA classification scheme to address latest developments in registration and introduction of new chemical classes, however, for the first time in addition to synthetic insecticides, IRAC has now covered biologicals and nematicides as well (Sparks et al., 2020). Some of the papers included in the Special Issue specifically covered toxicology work on both established insecticides (Reid et al., 2020; Shigetou et al., 2020), alkaloid extracts (Patel et al., 2020) and nematicides (Feist et al., 2020), but also candidate acaricides for Varroa mite control (Vu et al., 2020).

If resistance evolves, the understanding of molecular and genetic mechanisms is important to understand cross-resistance issues in order to implement appropriate resistance management tactics to protect fungicides, herbicides, insecticides, but also nematicides, which only recently gained more attention. Resistance monitoring programs, including both bioassay work and molecular diagnostic tools (Alavijeh et al., 2020; Lueke et al., 2020; Mezei et al., 2020), help to determine resistance allele frequency - particularly the presence of mutations driving target-site resistance - and thus aiding product choice for optimum efficacy and sustainable control. Likewise, the elucidation of mechanisms underlying metabolic resistance are crucial to understand the reactivity of molecules *in vivo* and provide a potential tool to screen for cross-resistance issues with novel compounds. New insect control technologies such as RNAi are promising tools in future IRM programs with low variation in sensitivity as shown for Colorado potato beetle populations collected across Europe by Mehlhorn et al. (2020). The field has recently gained momentum by a number of genomic and genetic tools such as CRISPR/Cas9 (reviewed by Douris et al., 2020), that have allowed to dissect molecular interactions between agrochemicals and interacting proteins as shown in two papers included in the Special Issue (Guest et al., 2020; Lueke et al., 2020).

Finally, we would like to thank the Editor-in-Chief, John M. Clark for his generous offer to collate the Virtual Special Issue, all authors for their commitment to contribute their articles and many reviewers for their valuable comments and suggestions helping all of us to shape this interesting issue, which hopefully attracts the broad readership of Pesticide Biochemistry and Physiology.

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