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Editorial: Latest advances in the biological control of vectors of human tropical diseases

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Editorial on the Research Topic

Latest advances in the biological control of vectors of human tropical diseases

Within this Research Topic we aimed to cover the different aspects of biological control of insects that transmit diseases to humans and animals, with a special focus on recent advancements in the field. Given the vast number of insect vectors, the diverse pathogens they transmit worldwide and the fact that the majority of these diseases affect regions of the world with low economic development, many of the insect vector-borne diseases are poorly studied.

Publications within this Research Topic covered the biological control approaches for three groups of insect vectors – mosquitoes, sandflies and triatomine bugs. For over a century insect vector control, including these three big groups of insects, was predominantly based on the heavy application of insecticides. Years of poorly controlled chemical use have led to the development of insecticide resistance, ecosystem toxicity, etc. In recent years, awareness of this negative effect has increased on a global level, and selected groups of scientists worldwide are turning to the development of natural ways to control insect vector populations.

As discussed extensively in the two published works by Vaselek (Vaselek; Vaselek) directly on the example of sandflies and the disease they transmit – leishmaniasis, there are multiple options available to facilitate the transition from heavy insecticide use to a more environmentally friendly approach. In addition to a comprehensive review of the literature related to microbial studies in sandflies, the author highlighted paratransgenesis as a promising new strategy with high potential to be developed and used for leishmaniasis control. There is still a long way to go before an effective paratransgenesis strategy can be applied to sandflies under natural conditions, but the advancements in the field of metagenomics significantly contribute to the fast accumulation of data. Regardless of this, future work in this field cannot focus on metagenomics alone. The author clearly pointed out that future investigations must be oriented toward the combination of metagenomics and culture-dependent methods. A combination of these two approaches

is necessary to obtain viable biological samples that can be used for genetic modification and ultimately for the development of paratransgenesis.

While paratransgenesis is slowly making its way into the field of sandfly-leishmaniasis control, the same author proposed the alternative option of utilizing already available resources – entomopathogens (Vaselek). The author carried out a thorough search and tracking of old and current knowledge related to the use of nematodes, protozoa and mites as biological agents of insect control, highlighting the mechanism of their infection and pathogenesis. The majority of these entomopathogens have a very high potential for further use in sandfly control. It was emphasized how current studies need to move from pure detection and identification to more practical evaluation under laboratory and field conditions in order to develop an environmentally friendly control approach.

In addition to sandflies and leishmaniasis, publications in this Research Topic addressed the control of Chagas disease. In the article by Dorn et al. the authors showed different strategies that were used to reduce the transmission of Chagas disease in Central America over several decades. The article described an integral strategy to interrupt vector transmission considering detailed scientific information about the vector (phylogeny, population dynamics, etc.), and the cultural, economic and social realities of the community. The strategy is based on the principles of achieving a better life, which the authors refer to as Ecohealth. The authors explained that the classical approach of using chemical insecticides has only a temporary effect, because resistant triatomines (*Triatoma dimidiata*) have re-colonized the study sites. This study provides a very good example of how new biological control methods can be used as an integral part of the Ecohealth strategy.

As new insect control strategies are developed, it is important to evaluate and compare their success under natural conditions in an objective manner. The article by Vásquez et al. evaluated the performance of biological control strategies involving mosquitoes using mathematical modeling. The authors introduced two new parameters called Suppression Efficacy Score and Time to Reduction Target, and emphasized the need for standard parameters. The article illustrated the advantages of using these new parameters directly for two mosquito control strategies for population suppression – (1) paratransgenesis (*Aedes aegypti* infected with *Wolbachia*) and (2) genetically modified male mosquitoes OX513A. The authors successfully showed the advantages of using simulation models to inform decisions about integrated pest management.

From another point of view, the development of effective biological control strategies or even vaccines/drugs to help eradicate vector-borne diseases requires a detailed understanding

of pathogen-host interactions. The work by Lacsina et al. provided in-depth and extensive information on the immunological mechanisms that are involved in vector-host interactions, in particular by analyzing the immune response that occurs during the bite of an insect vector on the skin of a host. The release of multiple molecules and the load of microorganisms during the vector bite activate the innate immune response, which contributes to the modulation of the specific adaptive immunity that will determine the course of the infection in the host organism.

Within this Research Topic we covered different approaches related not only to the highly complex scientific advances, but also to the sociological, economic and cultural aspects, which are often overlooked as a part of the integrated biological control strategy.

Insect-borne diseases are becoming increasingly important and they represent a great knowledge challenge.

It has become increasingly clear that climate warming is having a profound impact on habitat selection and the geographical expansion of insect vectors. In parallel with this, the increased rate of global travel/trade has significantly contributed to the importation and spread of insect-borne disease pathogens. These factors increase even more the risk of vector-borne disease outbreaks on a global scale. The overall health burden points to the urgent need for biological control of insects beyond their traditional hotspots in developing countries.

Author contributions

JV: Conceptualization, Writing – original draft, Writing – review & editing. SV: Conceptualization, Investigation, Writing – review & editing. MY: Conceptualization, Writing – review & editing.

Conflict of interest

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