1. Introduction – who was there first?

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Abstract

The force of vector-borne disease transmission is greatly affected by interactive processes between parasites and their arthropod hosts. In recent years significant advances in knowledge about the mechanisms of these interactions have been made, notably concerning the impact of arthropod immune responses on parasite establishment and propagation in the arthropod host, genetic and phenotypic variation affecting these interactions, the impact of these interactions on parasite and arthropod fitness, and how environmental factors affect parasite transmission. The current volume of the Ecology and Control of Vector-Borne Diseases highlights significant and novel aspects of parasite-vector interactions and contributes to a better understanding of vector-borne disease transmission. Better insight in these interactive processes will be useful for studies on the epidemiology and control of vector-borne diseases and is expected to contribute to the development of novel intervention strategies.

Keywords: vector-borne disease, parasites, pathogens, interaction, genetics, immunity, transmission

Introduction

Vector-borne diseases are characterized by the fact that one organism is dependent for its existence on at least two other organisms, one vertebrate host and one arthropod host. Examples are the leishmaniases with rodents as the vertebrate reservoir and sandflies (Diptera: Phlebotominae) as the arthropod hosts, dengue with humans as the vertebrate reservoir and *Aedes* mosquitoes (Diptera: Culicidae) as arthropod hosts and African trypanosomiasis, with various mammalian species as reservoir hosts and tsetse flies (Diptera: Glossinidae) as arthropod hosts. Historically, much attention has been paid to the parasite-vertebrate host interaction, as knowledge about this association is essential for understanding of the disease and contains clues for treatment. This includes research on the biology of parasites, the onset and progress of clinical disease, and preventive and curative interventions. Conversely, the parasite-arthropod interaction has received far less attention, presumably because it was originally assumed that passage of the parasite through the arthropod would not affect the latter. With hindsight, this was a remarkable attitude, as it was realized soon after the discovery of the role of arthropods as vectors that the parasites would require nutrients from their hosts for survival and reproduction (reviewed by Hurd 1990).

The realization that parasites can manipulate their arthropod hosts, or that the arthropods elicit effective immune responses against invading parasites coupled with rapidly-advancing technologies for parasite detection and identification (Sim *et al.* 2009, Valkiunas *et al.* 2008), has led to a growing body of research on parasite-vector interactions that has assisted greatly in our understanding of the biology of vector-borne diseases. For example, the development of real-time quantitative nucleic acid sequence-based amplification (QT-NASBA) techniques has led to the discovery of sub-microscopic infectious *Plasmodium* stages in the human host, suggesting that malaria parasite transmission may occur at a much greater scale than was believed hitherto (Schneider *et al.* 2007). Advances in immunology allow for a detailed understanding of the infectious route of *Plasmodium* spp. in anopheline mosquitoes (Chapter 2, Cirimotich *et al.* 2010). Molecular tools revealed the highly complex interactions between trypanosome parasites and their tsetse fly hosts, showing the effect of symbiotic interactions on successful parasite establishment following an infectious blood meal, as well as parasite multiplication and passage to the salivary gland (Aksoy and Rio 2005). These advances affect not only the true parasite-vector interactions, but also those involving true pathogens such as viruses, bacteria and fungi. Recent studies demonstrated the role of cellular mechanisms of *Ixodes ricinus* (L.) ticks (Acari: Ixodidae) in the establishment and subsequent multiplication of *Borrelia burgdorferi* spp. in the tick host (Schuijt *et al.* 2011), or of the impact of the mosquito host on the replication of dengue virus (Sim and Dimopoulos 2010). New insights about parasite-host interactions are not limited to direct interactions at the dual level of parasite and arthropod host, but also about environmental factors such as temperature, humidity and symbionts. For example, it was recently shown that daily temperature fluctuations greatly affect the transmission of *Plasmodium* (Chapter 5, Paaijmans *et al.* 2012) as well as dengue virus (Lambrechts *et al.* 2011) by their respective mosquito vectors. The relevant role of endosymbionts in the regulation of parasite-vector interactions is becoming increasingly realized, especially as the symbionts not only provide essential nutrients to the arthropod host, but also affect immune responses as well as the fitness of the parasite (Chapter 2, Hughes *et al.* 2011, McMeniman *et al.* 2009, Pinto *et al.* 2012). Recently, it was discovered that *Chromobacterium* spp. present in the midgut of mosquitoes possibly release anti-pathogenic agents that kill *Plasmodium* parasites as well as dengue virus (G. Dimopoulos, personal communication) and it is likely that microbial-vector interactions affect the successful establishment of parasites in the vector in ways that are not yet understood.

These examples are only a fraction of the vast amount of knowledge on parasite-vector interactions that has emerged in recent years. Such knowledge is likely to affect our understanding of vector-borne disease epidemiology, and can potentially be used for more effective interventions aimed at the control of vector-borne diseases. The revelation of malaria hot spots (Chapter 11, Bousema *et al.* 2012)) was only made possible through these advancements and provides new opportunities for more effective, targeted malaria control. The insertion of *Wolbachia pipientis* Hertig in *Aedes aegypti* (L.) has revealed a novel implementation of endosymbionts for the control of dengue virus (Frentiu *et al.* 2010) and will shortly be tested in dengue-endemic areas (S. O'Neill, personal communication).

The chapters in this third volume of ECVD highlight current advances in research on parasite-vector interactions, and provide proof that such advances are essential for the improvement of current disease control strategies. With the rapid advancement of insecticide resistance against malaria vectors (Asidi *et al.* 2012, Ranson *et al.* 2011) coupled with increasing drug resistance and the apparent spread of vector-borne diseases associated with environmental change (see Takken and Knols 2007), effective tools for vector-borne disease control are urgently needed, and studies that lead to better understanding of parasite-vector interactions will contribute to achieve that goal.

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