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Parasite–insect interactions: reciprocal manipulation

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Preface

It is probably a truism to say that what seems to be a single organism is, in fact, an assemblage of organisms – for there can hardly be an individual living outside a specialized laboratory that does not have commensals or parasites living within. The insects, the most diverse and numerous group of organisms on earth are no exception, and with micro- and macro-parasites from a wide range of taxa generate a remarkable range of interspecific associations. In some cases the insect is the sole host, in others it is an intermediate host or vector. It is the latter relationship which attracts much attention when insects and arachnids transmit infectious agents to humans, their animals or crops. Knowledge of the parasites of insects provides us with an opportunity to develop novel control methods for pests. Despite the diverse and widespread nature of insect infections, their impact on human well-being and the opportunity they give us to understand the complexity of the natural world, the subject remains a surprisingly neglected field. In this volume we endeavour to draw the veil from the 'black-box' approach to the insect stages of parasite life cycles to reveal some of the complexities of these relationships and how they are currently being analysed.

The central theme of this volume is the reciprocal nature of the interaction between insects and their parasites. The evolutionary 'arms race' between parasites and their hosts is a well worked concept but here we attempt to dissect the interaction further and distinguish those components of insect–parasite systems which are adaptive from those which are simply pathological effects. In this way a clearer understanding can be gained of the manipulative mechanisms employed by parasites and their hosts to maximize their own fitness and, in the case of the parasite perhaps even the fitness of the host. Thus we have taken a two-pronged approach in exploring the field. Firstly a physiological approach describing the mechanisms of manipulation, such as the intermediate stages of tapeworms down-regulating egg development in beetle hosts, and secondly, an evolutionary approach in which the consequences of manipulation of one partner by another are identified.

A wide range of insect–parasite associations have been drawn upon in this volume, including examples where insects themselves are parasites, i.e. parasitoids, in an attempt to bring together different subdisciplines of the classical fields of parasitology and entomology. Notwithstanding this attempt at breadth there are still large parasite taxa not discussed in detail, such as fungal parasites which can both manipulate host behaviour by causing ants, for example, to migrate up vegetation and maximize transmission to intermediate vertebrate hosts or modify the insects' environment in the case of saproxylic fungi associated with scolytid beetles.

At all stages of their development in the insect host, parasites and pathogens interact with the insect. In some cases this is to recognize specific cells for attachment or penetration, such as the case of plasmodia penetrating the mid-gut epithelia of mosquitoes, signals which may subsequently act as cues for parasite metamorphosis (e.g. trypanosomes in tsetse flies). Such specific cell recognition is undoubtedly a key aspect of species specificity, a mechanism most recently and comprehensively shown in the mosquito (*Anopheles* and *Aedes*)–*Plasmodium* and *Phlebotomus–Leishmania* systems. Perhaps the most obvious and significant interaction between parasites and insects involves the host's immune system. Among the exciting developments in this field is the discovery of the facilitating role of

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polydnaviruses in enabling parasitoids to suppress the immune response of the *Manduca* defence system. However, it is not only the insect immune system that plays a key role in pathogen transmission, the immunocompromised area surrounding the site of a tick bite can lead to tick–tick transmission of viruses without the previously expected amplifying infection in the vertebrate host.

Fitness costs are often imposed upon infected insects. In some cases a potential physiological mechanism has been proposed, as in the case of reduced egg production in cestode-parasitized beetles or in survival of trypanosome-infected tsetse flies. These identifiable costs are key to the development of theoretical studies on the relationship between such components as pathogenicity and parasite transmission strategy or of the resistance to infection.

Parasites and pathogens affect not only injurious insects of crops or vectors of disease but also insects beneficial to agriculture. However, attention has focused on the organisms affecting pestiferous insects with a view to their control. The role of parasitoids in the successful and, it has to be said sometimes unsuccessful, control of agricultural pests is well known. Much less explored, in a practical way, are the pathogens of vectors of human and animal diseases. Very few pathogens have found their way to field control, the most notable being *Bacillus thuringiensis* H-14. However, the prospect of transgenic organisms as a means of control has led to a search for an appropriate means of driving favourable genes through insect populations. Pathogens or commensals such as the ubiquitous *Wolbachia* are currently being evaluated in this capacity.

This volume arose from an Autumn symposium of the British Society for Parasitology in September 1997 in which researchers from a wide variety of disciplines were able to interact, sometimes for the first time. One of the delights of working on the interactions between disparate organisms is the opportunity to collaborate with specialists from different fields, whether they are related to different groups of organisms or different processes. We certainly have enjoyed hopping between disciplines in putting both the symposium and this volume together. Here we hope that entomologists and parasitologists can meet with evolutionary biologists on common ground and that this volume will hold something of interest for them all.

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